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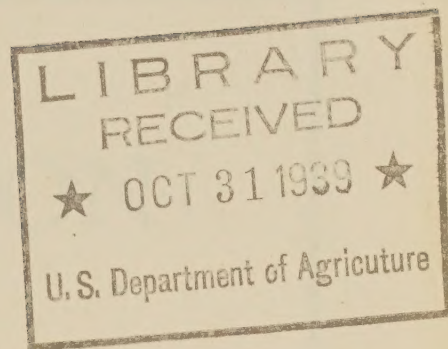


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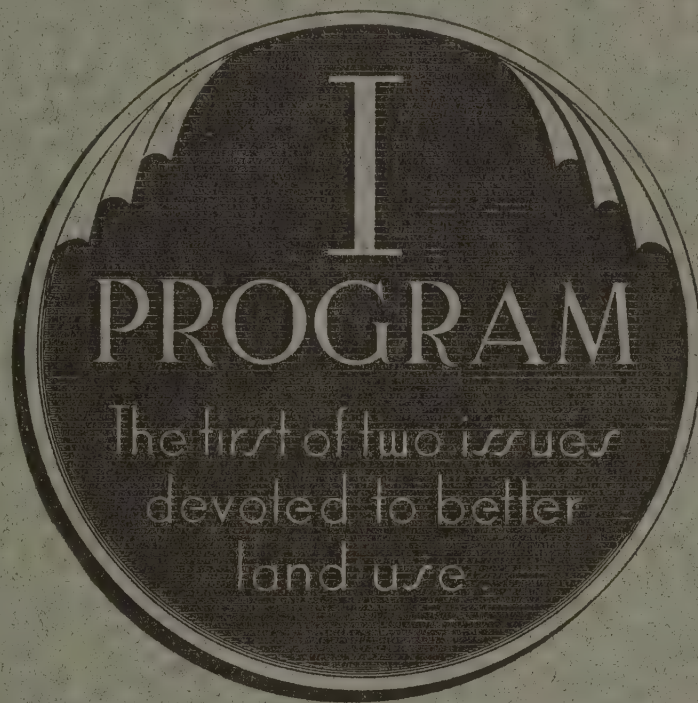
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SOIL CONSERVATION

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Volume Four
Begins With
This Issue

| JULY

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WELLINGTON BRINK
EDITOR

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SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. IV • NO. 1



H. H. BENNETT
Chief, Soil Conservation Service

JULY • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

Introductory Statement

WITHIN the Department of Agriculture there are a number of agencies administering land-use programs. There are programs for the control of erosion, for general agricultural conservation, for rehabilitation of disadvantaged farmers, for improvement of the tenure situation, for promotion of farm forestry, for retirement of submarginal lands from cultivation, and for flood control. All of these programs, and others, treat on land use. But each program points toward a common goal.

When the programs of the Department reach the farm they merge and become one program. This is essential. In the leading article in this issue, the first of two dealing with all of the Department's land-use programs, Secretary Wallace points out how the various parts intermesh, like the gears in an automobile, when the farm is reached. How this may be done with the least friction, with (to carry the simile further) the least grinding of gears, has been the subject of constant deliberation of State and Federal officials. One outcome of such deliberation is the proposal for a coordinated planning set-up for the counties, the States, the regions, and, finally, the country as a whole.

In this issue are gathered together between two covers definite, concise statements of the parts the various bureaus play in the over-all land-use program of the Department. SOIL CONSERVATION in opening its pages to these discussions is making a very real contribution to a better understanding of the Department's work and objectives; for our hope for success depends largely on our ability to reach agreement. If the Department's program is to go forward we must achieve a practical agreement on basic facts, we must be able to interpret these facts correctly, and in the light of these facts be able to determine desirable objectives and priorities; and then make the best possible adaptation of national programs to varying local conditions.

The factual background on work now under way, which is presented in this and the next issue of the magazine, should stimulate much thought and discussion, not only about the present activities of the Department but also about the steps which we must take to achieve improvement.

M. S. EISENHOWER,
Coordinator of Land Use Planning.

Our Land-Use Programs Intermesh

By Henry A. Wallace
Secretary of Agriculture



IN THE field of agricultural land-use programs Congress in the last 5 years has charged the United States Department of Agriculture with many new functions. These include programs for crop adjustment; crop insurance; soil conservation; marketing agreements; tenancy reform; the rehabilitation of the disadvantaged in agriculture; the purchase and development of submarginal lands; research, demonstrations, and actual erosion control under the Soil Conservation Act of 1935; land treatment for flood control; farm forestry; the improved utilization of water facilities; and increased forestry and wildlife activities. This is only a partial list. It sufficiently indicates, however, that the Department has become virtually a new institution with a very great responsibility for vast action programs.

As an aid to the action agencies in unifying these separate programs, the Department has established an Office of Land Use Coordination, which functions intensively in Washington and helps in the coordina-

tion of activities at regional headquarters and other field points. Naturally, the Office of Land Use Coordination deals primarily with administrative and policy problems. Nevertheless, the coordination of administrative procedures in land-use planning implies the coordination of fact-finding, and of Federal action with that of State and local agencies. It may be worth while to consider some of the implications. They extend far beyond the range that the first glance might suggest. Indeed, in the last analysis the requirements of coordination in land-use planning take us beyond administration and even beyond agricultural research, and carry us deep into the relationship between country and town, and into the network of social and economic facts and forces that constitute the rural-urban balance.

First, let us glance cursorily at some of the administrative requirements. It is necessary to begin with the coordination of all the physical and economic surveys on which program planning depends. Next comes the coordination of all phases of land-use planning. Next we must undertake the coordination of actual land-use programs and policies and of water programs and policies including land treatment for flood control. There is an important opportunity to promote the unification of programs through wise organization and procedural changes. Fundamental study of all agricultural and land-use legislation is necessary, so that as far as possible we may have an integrated legal basis for required activities.

It is necessary also to coordinate this Department's land-use planning, programs, and policies with those of the Farm Credit Administration, the National Resources Board, the Department of the Interior, and other Federal agencies. For example, there is a critical situation in the upper Rio Grande watershed in New Mexico. Here a large Indian and Spanish American population may become a permanent relief burden, through the progressive destruction of soil resources. Four bureaus of this Department and four bureaus of the Department of the Interior have established a permanent interdepartmental board to deal continuously and systematically with this problem.

Among the Department's more important objectives are: (1) Stability of farm prices, farm income, and rural-urban relationships; (2) the conservation of soil, water, forests, grass, and wildlife; (3) security of ten-

ure for farmers, with an increase in the percentage of owner farmers and better conditions for tenants; (4) higher standards of rural living and stability of rural communities through integrated crop adjustment and better land use. Needless to say, these objectives do not occupy watertight compartments. They are interdependent. Progress toward one type of objective requires equal and simultaneous progress toward the other ends.

Control of wind erosion in the Dust Bowl, for example, is more than a simple problem in moisture conservation and land engineering; it is a problem also in the organization of types of farming, in the improvement and stabilization of tenure conditions, and in the selection, balancing, and adjustment of crops. Similarly, the tenure improvement and purchase programs interact with crop adjustment and conservational activities. It is easy enough to recognize this basic truth. Actually to give it practical effect, through a harmonious working combination of different programs and techniques, involves difficult and continuous administrative coordination in Washington, in the States, and in local communities.

Along with the administrative coordination must go a parallel coordination of research. In the land-use programs perhaps more than in any other branch of the Department's work the need for action lifts the specialist out of his specialty and involves him in teamwork. It obliges him to see the whole as well as the part. Our land policy draws upon the economic and social sciences as well as upon agronomy, soil science, and land engineering. In other words, it affects the land user as well as the use of land. Specialists must look beyond their fences; they must broaden the concept of their responsibility. Otherwise, they will find it impossible to integrate the different sciences properly in the action programs, and results will be small for the effort expended.

The need for taking a broad view of the land question does not shove the specialist into a back seat or in any way depreciate the value of his special knowledge. Indeed, it puts a premium on research even of the very highly specialized type. But here is a relatively new thing in the application of agricultural research. Formerly, with the discovery of a useful fact or principle, the responsibility of the research worker tapered off. He could present his results to the farmer with a take-it-or-leave-it gesture. Research was mainly individualistic and so was the application. It is different now that public agencies have great responsibilities for action. It is necessary for research agencies not only to discover what should be done but to co-

operate with farmers and with other groups in putting the discoveries into practice. Besides the research that can be applied by the individual farmers, research specialists must now develop the kind of knowledge that can only be applied collectively through public agencies and farmers' organizations. As knowledge of this kind increases, research agencies find themselves involved more and more in teamwork for its practical application.

It would be easy to multiply illustrations. In land-use planning for different regions we need a blend of many different kinds of information. Are the land units so small that they will never furnish a livelihood? Are certain public agencies promoting the relocation of farmers in areas that other agencies regard as sub-marginal? Is there a proper integration of credit policy with land-purchase or crop-readjustment programs? How far can soil-erosion control through physical procedures be effective independently of action to sustain farm incomes or improve tenure conditions? Are we seeking to control erosion through benefit payments in regions where the principal limiting factor is the farm income or the prevalence of tenancy? What about the correct priorities in land-use planning—the order in which different things should be done? It is important to tackle first things first. Without an interchange of findings among different specialists and without the coordination of research findings, we cannot know the correct priorities. Then we become involved in unnecessary delay, expense, and inefficiency.

Special research in land-use planning needs to be set in a framework of general principles. Our A. A. A. programs through the effect on soil conservation and future land use modify the other land programs powerfully. Reciprocally, the research, demonstration, and localized erosion-control work of the Soil Conservation Service influence the A. A. A. activities. Tenancy reform promotes both crop adjustment and soil conservation; it gives more farmers an interest in the longer crop adjustment pattern, and in the conservation of basic resources. Without agreement among those responsible for the different programs as to what they should all mutually promote, there is bound to be unnecessary waste and conflict of jurisdiction. Obviously, moreover, the responsibility for developing this agreement as to broad objectives belongs not to any one branch of the



work but to them all. It must be the product of coordinated research and action.

But the agricultural land-use programs must look beyond agriculture. They must consider all land uses; those that employ the city workers directly and indirectly as well as those that employ the people on the farms. Agricultural land policy cannot be bounded by the farms, ranches, and forests, or even by the rural population; it should formulate alternative programs, one for the possibility that industrial revival will shortly restore the movement of population away from the farms and toward the cities, and another for the possibility that it will not. In the first case land not suited to farming can be shifted readily, as funds and other facilities permit, to forest, recreation, and wildlife purposes. In the second case, the shifting will meet with considerable resistance, and will need to be coupled with relocation programs and with special programs for relatively noncommercial agriculture. Agriculture is not in a position to solve industry's problem; but it cannot deal with the farm land problem without reference to urban conditions.

Modern technology has a consequence of great importance to agricultural land-use programs. Side by side with the commercialization of agriculture, technology produces an opposite movement toward self-sufficing ways of rural life. This is a very curious paradox. It results from the increasing productivity of the better lands. With commercial farming constantly reducing both the acreage and the labor required to satisfy a given demand, an increasing proportion of the rural population finds itself driven into relatively noncommercial farming. In 1929 half the farms in the United States produced only about 11 percent of the commodities sold or traded and since then the commercial production of this poorer half of our farms has dropped still more. Moreover, the number of small poor farms is increasing rapidly; it jumped 500,000 between 1930 and 1935. We have an immense rural group with an insufficient incentive to participate fully in the programs for crop adjustment and soil conservation. How may land-use programs be coordinated in the two halves of the rural system? Rural rehabilitation work, already immensely significant and useful, points the way.

Either we must arrest the trend toward noncommercial farming, through the provision of more attractive urban opportunities, or we must develop special programs for it. As an alternative to farm abandonment, which might be desirable in many areas from the standpoint of conservation, we may have to develop better types of rural self-sufficiency. As on the com-

mercial farms, it will be imperative here also to harmonize the human with the land requirements. Scientific programs for housing and sanitation, more diversified production, better preparation of food, and the rural interchange of services without the use of money, may prove helpful. Such measures should promote better land use on the poorer farms just as crop adjustments and marketing agreements do on the better ones. Much noncommercial agriculture is on land that ought not to be in farms; perhaps the best cure is to increase the supply of nonfarm jobs. Thus the land problem touches the urban problem at another point.

Still another great aspect of the land problem extends beyond agriculture to our society as a whole. Every land program encounters it eventually. This is the separation that tends to develop between the ownership and the operation of land. It is a world phenomenon, which has shaped the course of history dramatically many times, and will again. As the pressure of population increases, farmers bid up the price of land and burden the agricultural industry with debt. The result is agricultural insecurity. Buyers fail to attain full ownership, tenancy increases, newcomers invade submarginal land, and disputes arise over the division of the agricultural income as between mortgagors and mortgagees and as between tenants and landlords. History reports every conceivable attempt to deal with this problem, from the mild intervention of governments in questions of rent and tenure to violent agrarian revolution. In the United States, though already 42 percent of the farmers are tenants, the difficulty is still in an early stage. Yet the Government has found it necessary to act, through measures for the raising of tenants to ownership and for the improvement of the leasing system.

These observations are strictly within the confines of the land problem, which is simply a part of our general economic and social problem. Frequently, the agricultural approach begins in particular areas of submarginal farming, of extensive tax delinquency, of overgrazing, of excessive erosion, or of reckless forest destruction. It is sometimes necessary to begin there. But such problem areas are not isolated sore spots; they are outcroppings of more general disorder in the agricultural and social system. It is vital to attack also the general land-use evils, of which the problem areas are merely the local expression. The task involves the combined action of many technical agencies, including those concerned with the soil, with farm management, with crop adjustment, with erosion and flood control, and with forestry. It brings physics,

(Continued on p. 13)

Economic Objectives of the Land-Use Program

By L. C. Gray¹

ALTHOUGH the ultimate purpose of the land-utilization program of the Bureau of Agricultural Economics is, to quote part of title III of the Bankhead-Jones Act from which its authority is derived, to "assist in controlling soil erosion, reforestation, preserving natural resources, mitigating floods * * * and protecting the public lands, health, safety, and welfare," its methods of achieving good land use and conservation are primarily economic, the physical development of land playing a secondary part.

In almost any agricultural area in the United States where the evidences of land waste are found—soil erosion, dust storms, human poverty, and devastated forest or range—there are economic influences which have helped bring about the misuse of land. In order to meet their living expenses, taxes, and interest, farmers on submarginal land have cut over their woodlots or overgrazed the range. Submarginal land, like insecure tenure, prevents them on the one hand from practicing long-term conservation, while on the other hand it forces them to consume their capital assets of soil, trees, or grass.

The analysis of these economic problems, and the planning of the program for their solution will be discussed in a later article. In its action program the Bureau is developing land-utilization projects that will bring about a more desirable economic basis for land use, and thereby make possible the conservation and permanent use of land resources for the benefit of local communities dependent upon them. The key instrument for the achievement of this goal is the purchase of lands unsuited to cultivation, as authorized in the Bankhead-Jones law. But several different instruments, particularly those provided by State or local action, are brought into play wherever possible, in order that the broadest possible benefits may be achieved. Land-utilization projects, therefore, represent in a large number of cases, cooperative efforts on the part of both Federal and State or local agencies toward the solution of given problems of land use. A simple clarification of the problems encountered will help to explain the operation of the program.

So far as land use is concerned, there are two major problems which either singly or together lie at the heart of the economic trouble spots in our agricultural map. The first of these is the settlement of lands that

are not suited to cultivation: there are upwards of half a million farm families occupying about 86 million acres in farms that are incapable of providing an adequate livelihood through crop cultivation. Then also, an additional several hundred thousand families are living on farms that are either too small or too large for economic operation. In either case, the results are similar from the viewpoint of the community. Poor land results in depleted resources and farm poverty; this in turn breeds tax delinquency, excessive costs for local services such as roads and schools, and increased relief.

The Bureau's program has grown out of an extensive land-purchase and development program that started in 1934 under the joint sponsorship of the Federal Emergency Relief Administration, the Agricultural Adjustment Administration, and several other Federal agencies both in and outside of the Department of Agriculture. A leading purpose of this program was to retire submarginal land from crop production and develop it for grazing, recreation, wildlife conservation, forestry, and other public uses. From this earlier program was drawn the experience upon which the present program is based. Authorized by title III of the Bankhead-Jones Act of 1937, the land-utilization program of the Bureau of Agricultural Economics is now focused primarily upon the rehabilitation of distressed agricultural areas. The purchase of submarginal lands, and cooperation with State and local governments in action that is within their sphere, are governed by this objective.

Within the broad outlines of the Nation's land problem areas, the specific location of the Bureau's land-use projects is determined in part by the extent of local cooperation offered in the development of desirable land-use practices. State and county zoning programs, organization of cooperative grazing associations or soil-conservation districts, and the development of effective State programs for handling tax-reverted land are among the leading directional measures which can supplement the purchase of submarginal land in problem areas.

During the present year, the major emphasis in the land-utilization program has been placed on the Great Plains, because of the pressing need for rehabilitation in that region. Consequently, the program of land utilization has gone farther in that region and more

¹ Assistant Chief, for land utilization, Bureau of Agricultural Economics.

effective results may be seen there than in other parts of the United States.

Throughout the Great Plains region, wherever wind erosion with impoverishment of farmers and the disruption of local public finances has been severe, large numbers of operators are usually encountered who are either living on land that is unsuited to crop production, or on units too small for economic operation as stock ranches. In the serious problem areas, restoration of the grass cover on land that will not support crops is necessary in order to conserve the soil itself. The development of stock ranching, in combination with limited cultivation of feed crops, is generally the type of land use which natural conditions indicate as desirable. Projects of the Bureau's land-utilization program combine the purchase of certain tracts unsuited to cultivation with the application of local measures designed to achieve the pattern of stock ranching and feed production that is needed in any one area.

In central Montana, for example, lies a problem area of several million acres wherein dry-land farming was greatly over-expanded. As a result of widespread farm abandonment and tax delinquency, a confused and complicated pattern of ownership developed. Larger ranches were interspersed with small dry-land farms of one section or less. Private lands were intermingled with public domain, railroad grants and tax-reverted tracts. Many homesteads had been abandoned and remained idle and unprotected. Because of the lack of unified management, the carrying capacity of the range had decreased from one-quarter to one-half of its former capacity. Private owners, either because they could not obtain control of much of the land, or because they had no means of disposing of their small dry-land holdings, were unable to solve the dilemma.

In this area, the land-utilization program first established the central Montana project in Musselshell and Petroleum Counties. Some 260,000 acres of land unsuited to farming were purchased as the first step in developing a large range that could be managed constructively for the use of local stockmen. The land purchased consisted primarily of these three types: Small, dry-land farms owned by families who wished to move to other areas; abandoned homesteads over which no satisfactory control could be exercised without Government purchase; and selected tracts located at strategic points throughout the whole project area on which water facilities could be developed for the improvement of the range.

While plans for purchase were being developed,

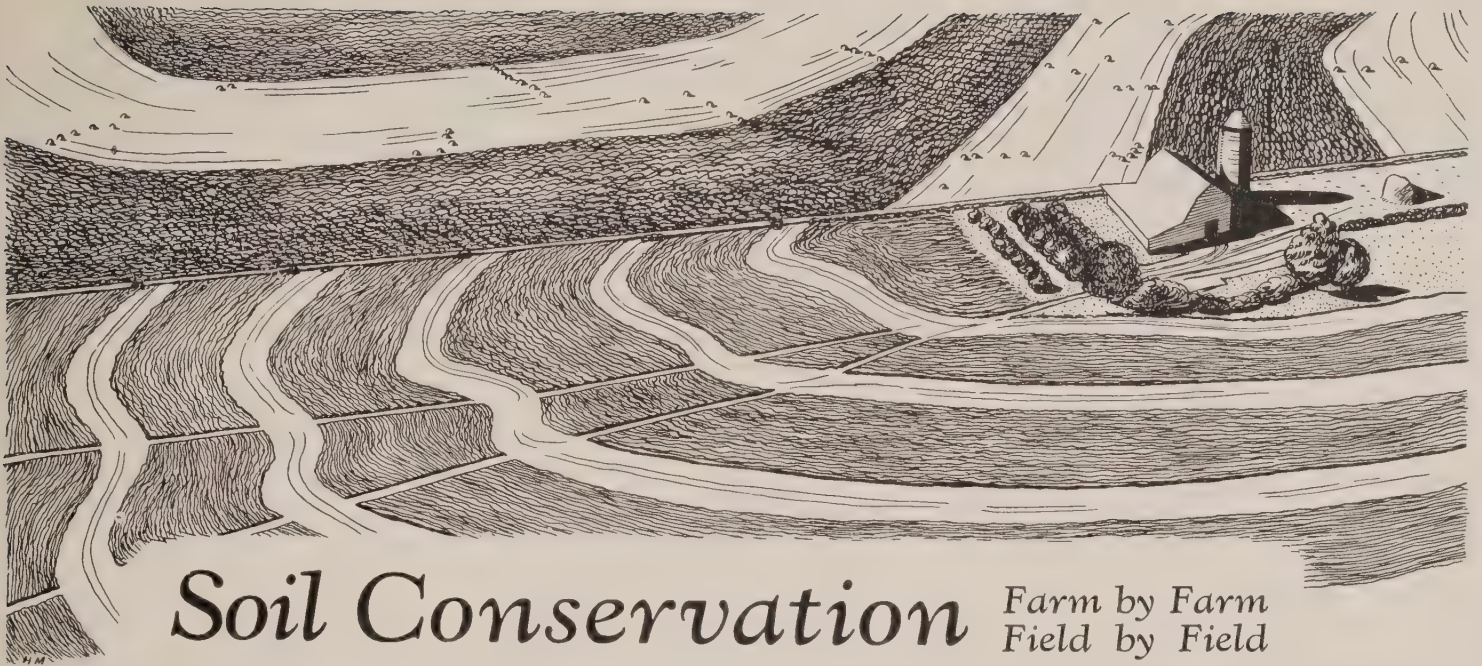
the cooperation of local stockmen in the area was sought in a joint attempt to put the range under constructive management. Through the provisions of the State grazing districts law, a means was available to develop control over much of the area without Federal purchase. Local stockmen, seeing their advantage in a program of range management, organized cooperative grazing districts under State law, and proceeded to lease privately owned land, State land and public domain in addition to tracts purchased in the land-use program. Thus, together with the purchased lands that were scattered through the project area, it became possible to place a total of more than 1,000,000 acres under constructive range management.

Following the purchase of lands in this project there came the improvement of these lands for range use through the employment of relief labor. Useless farm buildings have been obliterated and fences rearranged to suit the new pattern of management. Of primary importance has been the development of 220 stock watering places, mostly in the form of catch basins and reservoirs formed by small dams. Former cultivated fields have been reseeded to grass, while contour furrowing has aided natural revegetation by conserving water. These various developments have been accomplished by means of funds made available by the W. P. A. The entire purchased acreage has been leased to the local grazing associations for management through the operation of the Taylor (Federal) grazing district, subject to specific regulations that will ensure the conservation and proper use of the area.

During the present year the original project in central Montana has been expanded into neighboring counties. The increased scope of activity will result in the constructive management of approximately 4 million acres, of which only about 10 percent is being purchased in the submarginal land program. Because of the improvement of the range, resulting from proper management and development of new water supplies, the area should gradually be built up to a considerably higher carrying capacity than it now offers, and thereby be able to support more and larger herds.

Cooperation with other land-use and agricultural agencies is an essential part of the better land-use program of the Bureau. In most project areas, the shift toward a less intensive use of land, such as from crops to grazing or forestry, necessitates a relocation of at least some of the families from the area. This is being done through the cooperation of the Farm Security Administration as well as with the help of local

(Continued on p. 13)



Soil Conservation *Farm by Farm Field by Field*

By H. H. Bennett ¹

THE use of land for agriculture is governed by a variety of social, economic, and physical considerations. Conceivably, man can temper the operation of economic and sociological forces; but he cannot change the broad lay of the land or the weather. Nature, in other words, imposes certain absolute limitations on the use of land.

The problem of soil erosion arises, basically, from man's failure or inability to adapt his use of the land to these physical limitations. This failure or inability is largely due to custom, or to economic and social pressures. But whatever the forces which impel or encourage it, use of the land without consideration of natural physical limitations is the immediate cause of soil erosion.

Ideally, complete and effective conservation of the soil would mean complete harmony between physical adaptability and land use. Realistically, however, in view of considerations other than the purely physical, such a relationship is not always possible. Instead, practical soil conservation becomes a matter of achieving the maximum degree of harmony between land adaptability and land use in the light of economic and social exigencies.

A Dust Bowl farmer, for example, may be anxious and willing to conserve his soil by farming his land in complete accord with natural limitations. But his holdings may be too small to provide an economic operating unit under best land-use practices; under pressure of debt, he may be impelled to seek profits from exploitative farming in periods of high prices; or soil blown

from adjoining land over which he has no control may be covering his fields and crops. For these, or any of a number of other reasons, he may be unable to farm as he should in order to conserve soil. In his case, economic and social pressures prevail and, as a consequence, soil conservation becomes a matter of doing the best that can be done under the circumstances. Broadly speaking, the necessity of making such concessions can be obviated only by eliminating, or mitigating, the social and economic maladjustments which now operate to impede conservation action.

Thus, in order to realize maximum effectiveness, the physical land-adjustment program of the Soil Conservation Service must be accompanied by economic and social adjustment. Efforts to bring about adjustments of this latter type on a large scale are now being made by the Soil Conservation Service and by various agencies of the Department in a synthesized national action to achieve better use of land resources. The role of the Service in bringing about better use of land must be considered, therefore, in relation to the other action programs now attempting to cope with the diverse facets of the broad problem of land use.

For the past 4 years, the Service has operated demonstration areas in representative agricultural regions to show the best methods of dealing with typical erosion problems. These areas have been described as "show windows of soil-erosion control." To them come farmers from the surrounding countryside to inspect and study the most practical methods of conserving soil and water resources. Practicability is a requirement of all measures demonstrated so that a farmer,

¹ Chief, Soil Conservation Service.

at least theoretically, should be able to return to his own land and install the same measures, with minor variations, according to his needs. Thousands of farmers have followed this procedure. Other thousands desire to, but find their wishes at least partially or temporarily nullified by realistic economic problems. Payments to farmers cooperating with the program of the Agricultural Adjustment Administration are helping to break down this impediment to soil conservation. Soil conservation districts, established under State laws, are also doing their part to bring about more widespread conservation of soil resources. Because of their promise as a medium for extensive spread and utilization of soil- and moisture-conservation measures, present plans of the Service call for emphasis on cooperation with these local organizations.

More than 500 soil-conservation demonstration areas now constitute proving grounds and sources of authoritative reference for erosion-control measures in 45 States. And recently a demonstration was established in Puerto Rico.

Half of the land covered by the cooperative agreements in these areas has already been protected against erosion. On the remaining acreage conservation work is being carried forward as rapidly as possible. Briefly, the agreements now in effect mean that about 3,500,000 acres in the present demonstration areas will be farmed with approved crop rotations. Some form of strip cropping will be followed on more than 1,500,000 acres. Terracing will help protect almost 2,000,000 acres. Approximately 3,000,000 acres will be tilled on the contour, instead of in erosion-inducing, straight rows, and more than 500,000 acres will be protected by seasonal cover crops. Additional thousands of acres will be protected by various other erosion-control measures.

Concurrently with the demonstration program, the Service carries on investigations and research in many aspects of the soil-erosion problem. At experiment stations located in representative agricultural regions, the effectiveness of various kinds of land cover and land treatment for prevention of needless loss of soil and water is being tested and measured. Studies are being made to establish fundamental data on the nature, causes, and effects of erosion, and to develop new and improved methods of control. Two "watershed" laboratories for soil conservation have been established to ascertain the exact effectiveness of erosion-control measures applied over a large area. At the same time, studies at these laboratories will help in determining to a greater degree of accuracy

the part which land-use measures may play in reducing the hazard of floods.

Other studies are being made to determine the relationship between erosion of the soil and costly silting of reservoirs. Climatic investigations are under way to provide a sounder basis for setting up erosion-control measures that will be more nearly 100 percent effective. No little attention is being given to the economic aspects of soil-conservation work, and in a number of other related fields, research is progressing.

Cooperatively, the Soil Conservation Service is working with the Bureau of Public Roads in the development and demonstration of highway erosion-control measures, with the Forest Service in encouraging greater care and utilization of woodlands, with the Biological Survey in establishing habitats for wildlife and encouraging an increase in the wildlife population on agricultural land, and with the Bureau of Agricultural Economics in the development of accurate economic information relative to soil conservation.

The Service also contributes to improved land use by making available to the Agricultural Adjustment Administration, the Farm Security Administration, the Indian Service and other agencies, fundamental soil-conservation information. In turn, the soil-conservation objective of the Service is furthered by the social and economic programs and benefits of these cooperating agencies.

Since it was established, the Service has operated in close cooperation with State agencies, particularly with the Extension Service and Experiment Stations. During the past year a new avenue of soil-conservation cooperation has opened—an avenue significant because of the promise it holds for speeding up the widespread adoption of conservation practices. This is the soil conservation district.

For some time it has been recognized that the soil-erosion problem of the United States could never be satisfactorily solved by Federal action alone. The task is too vast and too complex to be achieved in its entirety by a central governmental agency. While Federal agencies are needed to point the way toward better land use through technical advice and assistance, the initiative and actual work of conservation on a large part of the country's tillable land and range land must be undertaken by the farmer and rancher.

It is at once evident, however, that individual efforts to control erosion are likely to be ineffective. They can be costly and can never be anything but piecemeal. The one system of attack on erosion that promises success is the cooperative attack, beginning where erosion begins, at the crests of ridges, and work-

ing down, farm by farm and field by field, to the stream banks in the valleys below.

To speed this type of cooperative action, the soil-conservation district was designed. It is simply a mechanism whereby farmers or ranchers within a watershed, or other natural land-use area, may organize for community action and mutual protection in combatting the soil-erosion problem. During 1937, 22 States passed laws permitting local groups of farmers to organize such districts. By April 25, 1938, 39 districts had been formed in 11 of the States and several others were in the process of formation. Eventually, it is hoped, a significant portion of the Nation's erodible land will be included in similar districts.

In opening the way for establishment of soil conservation districts, each of the State laws passed to date has set up a State soil conservation committee, composed usually of the heads of various State agricultural agencies. This committee is empowered to make the legal determinations necessary in the creation of districts, to encourage the organization of districts, to bring about an exchange of information among districts, and to coordinate the several district programs of the State "so far as this may be done by advice and consultation." Once a district has been established, however, it is an independent unit, a subdivision of the State, and is not subject to control by the State soil conservation committee.

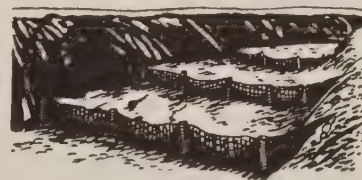
Proceeding under the leadership of two appointed and three elected supervisors, a district may decide to follow a program similar to that now being carried forward in the demonstration areas of the Soil Conservation Service. One of the first steps will probably be a conservation survey of the entire district, showing slopes, soil types, prevailing land-use practices, and existing erosion conditions. On the basis of this survey, the supervisors can draw up an erosion-control program to meet the needs of the area. They may enter into agreements with farmers and help them in developing soil-conservation plans for the individual farms. The supervisors may provide farmers of the district with technical assistance, and make loans or grants of machinery, seeds, planting stock, or other necessary supplies. In some instances, they may also offer the farmers a certain amount of financial assistance. And in furtherance of its objectives, the district may enlist the assistance of State and Federal agencies through the medium of the State soil conservation

committee. To date, the Soil Conservation Service has entered into agreements with 23 districts in 6 States.

In all the work of the Service, whether it be in demonstration areas, research projects, or in cooperation with soil-conservation districts, it is recognized that the agricultural lands of the country have a wide range of possible uses. They may produce trees, grains, grasses, or any of a number of other crops. They may serve other useful functions, aside from crop production. In other words, judged purely from a physical standpoint there may be a variety of land uses which would serve equally well in conserving soil and water. In the furtherance of better land use, however, the program goes beyond strictly physical considerations. It also takes into account the important social and economic aspects involved. Recognizing that there may be several equally efficient uses for any farm or field from the standpoint of soil conservation alone, there is normally only one "best" use for that land after the introduction of vital social and economic considerations.

In an ideal program for the conservation of soil, highly erodible areas would probably be clothed with trees or grass, and cultivated crops would be restricted to the less erodible slopes and nonerodible lands. Cultivated fields would be protected by such safeguards as strip crops, terraces, and other measures. Soil-saving and soil-improving rotations would displace soil-depleting and erosion-permitting cropping systems. But social and economic factors must temper the ideal physical program, for conservation of soil is not an end in itself—it is not worth while simply because the principle of conservation seems desirable. The true value of protection for the Nation's soil and water resources is found only in the present and long-time benefits which such protection brings to all the people. The soil-conservation program is possessed of human considerations; it does not seek mere abstract, inanimate permanence of land.

From the outset, the Soil Conservation Service program has been based on the axiom that every field, and every farm should be used according to its individual needs and adaptabilities, insofar as compatible with economic and social limitations.





THE FARMER'S PLEA IS FOR ECONOMIC SECURITY

To Conserve Farm Income and Soil Resources

By H. R. Tolley¹

BOTH the basic and the supplementary phases of the national farm program were planned with the idea of establishing an efficient farm system which will return farmers a reasonable income and which will produce and keep on hand enough food and fiber for the Nation. The program is designed to conserve soil resources and to balance agricultural and industrial income, so that not only shall there be enough farm products, but also enough purchasing power in the hands of farmers so that they may enjoy the same standard of living as the other groups in our population.

Specifically, the current program of the Agricultural Adjustment Administration is concerned with three phases of the plan of the Federal Government to help the farmers of the country in stabilizing supplies and income and in encouraging agricultural conservation. These phases are (1) acreage allotments and soil-building goals, (2) loans on the security of stored farm products, and (3) marketing quotas for certain commodities, to be used only when supplies are excessive.

The stabilization efforts of the A. A. A. program begin with farm production. The mechanism for initial operation is the national acreage allotment for soil-depleting crops. This mechanism is designed to bring about a decrease in cropland devoted to soil-depleting crops, but not to decrease such plantings below the level required for adequate production.

The allotments represent the carefully calculated volume of farm production which will be required to establish a supply adequate to meet all requirements of domestic consumers of farm products, to supply all export markets which offer returns large enough to justify extra farm labor and the exploitation of the land, and to establish and maintain reserve supplies of farm products larger than the country has been in the habit of maintaining in the past. These reserves constitute the beginning of the ever-normal granary. They safeguard farm income and city consumer against years of crop scarcity.

The national acreage allotment for a given crop or group of crops is that acreage which, at normal yields, will produce the supply that has been described. The level of that supply, for each of five commodities (cotton, corn, wheat, tobacco, and rice), is specified in the Agricultural Adjustment Act of 1938.

This acreage, for the country as a whole, is distrib-

uted among States, counties, and individual farms. Past production records are taken into account in dividing the allotment among States and among counties. In working out acreage allotments of soil-depleting crops for individual farms—a job which is done by local and county committees of farmers elected by farmers—the size of each farm is considered and the degree of erosion, the lay of the land, and other pertinent factors.

Special acreage allotments are worked out for cotton, wheat, and rice, and for corn, peanuts, and potatoes in areas where these crops are commercially produced and marketed. In addition there is a “general soil-depleting crop acreage goal” which includes all other soil-depleting crops.

In order to qualify for benefit payments under the A. A. A. program the first thing a farmer does is to keep his plantings of soil-depleting crops within the acreage allotments that have been worked out for his farm. The result is that if yields are normal, the country as a whole produces enough to meet the requirements that have been enumerated, without wasteful overproduction or price-breaking surplus of any one of the soil-depleting cash crops.

Participation in this program is wholly voluntary. There is no penalty for overplanting. Exceeding an established soil-depleting acreage allotment means only that payments which might have been earned by staying within the allotment are reduced or forfeited.

The other part of the conservation program is based on the knowledge that the reduction of soil-depleting crop acreage alone will not conserve the soil and fulfill the purposes of the national land-use program. Conservation and improvement of the soil call for definite and positive measures.

Therefore, in addition to acreage allotments for soil-depleting crops, a “soil-building goal” is established for each individual farm. This goal can be achieved through the use of such practices as strip-cropping, contouring, planting soil-conserving crops or trees where needed, etc. In order to qualify for full benefit payments, cooperating farmers must follow practices which will achieve their goals; if they fall short of these goals, payments are reduced or forfeited. The practices through which farmers can qualify for payments are selected and approved with regard to different regions and the conditions in those regions. In the semiarid regions, conservation of water, restoration of

¹ Administrator, Agricultural Adjustment Administration.

depleted ranges, and means of preventing wind erosion are important.

When supplies are adequate or more than adequate to meet the current needs and to fill the ever-normal granary, commodity loans are an aid to farmers in maintaining adequate reserves in storage.

For their incomes, farmers depend on the sale of their crops. If they are hard pressed for money, as they usually are, they may be forced to sell whole crops as soon as they are harvested. Furthermore, it costs money to store farm crops such as wheat, cotton, corn, tobacco, and rice.

To prevent the emergency wherein farmers are forced, just at harvest time, to throw whole crops on a market which may be over-supplied, or to sell it to speculators who will hold it in the hope that scarcity later will force the price to a high level, the A. A. A. program provides for loans to farmers, on the security of their stored commodities. Such loans give the farmer an immediate return of at least a part of the value of his crop, and enable him to hold some of the crop in reserve to be moved to market when it is needed and when the price is fair.

Such storage supplies guarantee consumers that food, feed, and fiber crops will be available for purchase at less than scarcity prices; they guarantee farmers that they will have supplies to sell even in years when crops are short.

The loans, made through the Commodity Credit Corporation, may be made on any agricultural product, although the law directs that those on certain commodities will be subject to specified conditions. As the law prescribes, the rates and other conditions will be designed to prevent collapse of farm prices, and to facilitate the movement of crops to market when they are needed.

In addition to commodity loans, the Agricultural Adjustment Act of 1938 provides for crop insurance for wheat growers, beginning with the 1939 crop. The insurance plan calls for payment of both premiums and indemnities in actual wheat or its cash equivalent. As a result, the plan is an aid to the establishment and maintenance of reserve stocks of actual wheat, to the advantage of both producers and consumers.

While crop insurance is at present provided for wheat only, later as it is tested and developed, the plan may be extended to other crops.

Under the first step of the A. A. A. program the Government helps farmers to establish a soil-conserving and balanced production. Under the second step the Government makes commodity loans to enable

farmers to keep enough on hand for their welfare, and for the safety of consumers.

A period of several years of unusually good growing weather and high yields might build up supplies of farm products to levels above the requirements of domestic consumers, above the possibilities for exports, and above any reasonable need for reserves against scarcity. This could happen even if acreage allotments, which are figured on the basis of average yields, are observed and soil fertility is conserved. As a matter of fact, the soil-conservation features of the program will increase acre yields and the size of the crops harvested from a given acreage.

If acreage allotments are not observed, with unusually favorable growing conditions the granary will rapidly overflow. To prevent this, with flooding markets and breaking down of farm prices, income, and buying power, the Agricultural Adjustment Act of 1938 establishes marketing quotas to regulate the volume of cotton, corn, wheat, tobacco, or rice as it moves through interstate commerce channels to market.

The act specifies, for each of the commodities listed (and for no others), the levels to which supplies must rise before a marketing quota for the commodity can become effective. These supply levels are fixed at points so far above the normal requirements and the desirable reserve stocks, that reaching them would constitute a definite menace of crushing, wasteful surplus, and market collapse.

The act specifies also that when and if supplies reach such excessive levels, marketing quotas may be used. The national marketing quota represents the same amount of the crop in question as is provided by the national acreage allotment for that crop—that is, enough for domestic and export requirements and for a large carry-over.

When the supplies are at the excessive levels which the act specifies, producers of the commodity in question are asked to vote in a referendum on whether or not they approve the quota.

If two-thirds or more of the producers voting are in favor of the quota it becomes effective; otherwise it does not. In March of 1938, producers of cotton and of flue-cured, dark air-cured, and Burley tobacco voted in referendums on marketing quotas of these products. The supply of each, in sight for the marketing year 1938, has reached the levels specified in the act. In all cases, the producers voting favored the application of the quotas by majorities much larger than the required two-thirds.

When a national marketing quota for any commodity becomes effective, it is distributed among individual farms much as acreage allotments are distributed. The distribution is so made that it gives to each farmer his equitable share in the marketing of the crop just as the acreage allotment gave him his equitable share in the production of the crop.

The act prescribes penalties for each bushel or each pound of a crop marketed in excess of a farm's marketing quota. This penalty, collected through the buyer of the product and turned in to the United States treasury, amounts to 15 cents per bushel of corn or wheat, 2 cents per pound of cotton, etc.

The act provides that when a marketing quota is in effect, loans on that crop shall be made available to producers to help them carry over that portion which could not be marketed without a penalty.

It provides that should a new and larger need for the commodity develop during the marketing year for which the quota is in effect, the quotas shall be adjusted or lifted entirely and the commodity released to market.

At the end of the marketing year in which a quota is in effect, the amount of the commodity which has been carried over under the quota provisions is figured into the supply for the following year in determining the national acreage allotment. Thus if a huge surplus accumulates but is withheld from the market, the acreage allotment for that crop for the following year is correspondingly reduced.

These three steps—acreage allotments to encourage soil conservation and the production of sufficient but not wasteful surpluses, loans to help carry over reserves, and marketing quotas to prevent market collapses—make the framework of the A. A. A. program.

Additional features of the program, designed to aid in carrying out the purpose, may be mentioned briefly. One of these is the provision by which the Government may purchase burdensome surpluses of certain commodities, remove them from regular market channels, and use them for the relief of the needy and unemployed. Operations through which the Government assists in financing the diversion of certain surplus products into new uses at lower prices are proving of value in the furtherance of the plan. And, finally, two other provisions may be pointed out as contributing greatly to the program: (1) That which authorizes the establishment and maintenance of marketing agreements on some commodities to stabilize their movement to market, to avoid waste, and to obtain better returns for the growers; and, (2) that which provides for the finding and developing of new uses and markets, both domestic and export, for farm products.

ECONOMIC OBJECTIVES OF PROGRAM

(Continued from p. 6)

agencies. Credit facilities are also needed to help achieve a better land use, particularly in the Great Plains region, that farmers may have assistance in shifting from crop production to livestock. Finally, agencies such as the Soil Conservation Service, the Forest Service, and the Biological Survey have provided technical guidance in the improvement of the purchased lands, as well as in some cases actually undertaking development work.

Much of the work of the land-use program conducted by the Bureau of Agricultural Economics necessarily has been demonstrational. This was true particularly where the need for improved land use was not paralleled by the development of local means to promote the conservation and wise use of land. In these instances land was bought in more solid holdings and was developed for public ownership and management as demonstrations in multiple-use for forestry, wildlife conservation, recreation, and pasture improvement. An example of this type of project is seen in the Clemson College land-use project in South Carolina. State agencies, under the leadership of the college, plan to take over this 23,000-acre area, consisting largely of badly depleted cotton farms, and manage it as a forest, public park, and wildlife area. Special demonstrations in pasture improvement are maintained on some of the lands.

In some of the States, notably Michigan, Minnesota, and Wisconsin, local and State programs for handling submarginal lands have been developed on a broad scale, and this makes possible an effective coordination of State and Federal land programs. In others, public understanding of land problems has not yet reached the point where effective action is possible. The demonstration projects of the Bureau's land-utilization program are being made the center of educational activities that will help to stimulate local interest and action as the basis for future cooperative endeavors.

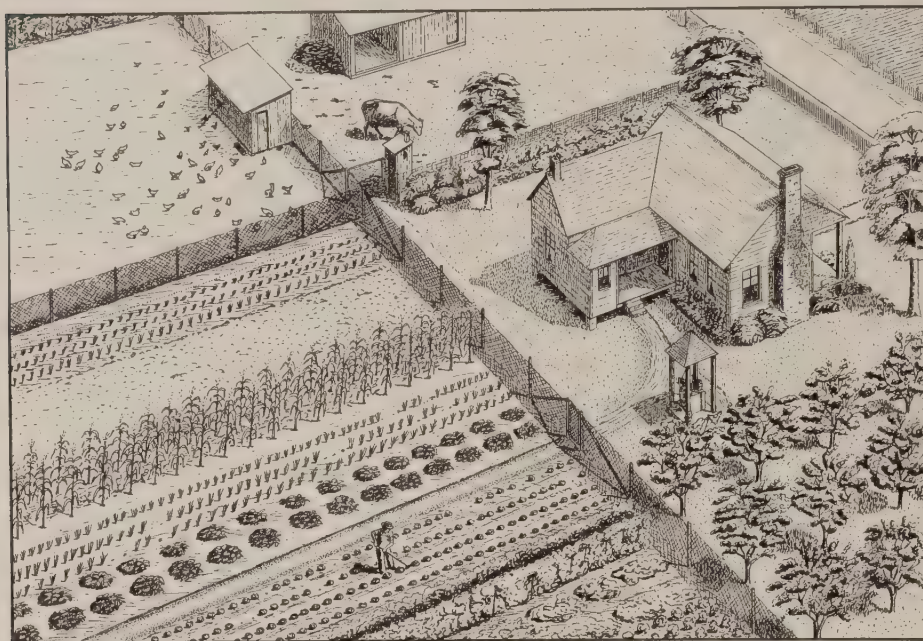
OUR LAND-USE PROGRAMS INTERMESH

(Continued from p. 4)

agronomy, and biology into an applied combination with the social sciences, in an orbit that includes the whole of agriculture and considerable segments of the urban economy as well. Research and action programs must fit together, and come into a dynamic focus on the farm and on the watershed. Also, they must mesh with urban policy.

The Rehabilitation and Tenancy Programs

By W. W. Alexander¹



ONE of the most important innovations in the Government's land policy is a more direct concern for the welfare of the people who make their living from the soil.

For more than a century it was possible to follow a land policy which paid no special attention to the people on the land. They could be virtually disregarded so long as a farmer could move to new land in the West when his old farm was exhausted or could readily find work in the cities.

Today, with widespread unemployment and with no more free land capable of producing a decent living the old approach to land problems has become inadequate. It is now generally recognized that any program for the proper conservation and use of our natural resources must consider the people who live on the land as well as the land itself.

Unwise use of the land was largely responsible for the condition of more than a million farm families who were in urgent need of relief during the depths of the depression. Many of these five million people had been ruined by floods or droughts, and all of them had suffered severely from the general business decline; but these were not the sole causes of their difficulties. The great majority were the victims of long-neglected soil erosion, careless and unscientific farming practices, inadequate acreage, insecure tenure, over-burdening debts and a prolonged period of depressed farm prices.

Since it obviously would have been both expensive and demoralizing to carry these families indefinitely on direct relief, the Government has attempted to help them reestablish themselves as self-supporting farmers. This task of rehabilitation was entrusted to the Resettlement Administration, and more recently to its successor the Farm Security Administration.

Many needy families had access to land suitable for farming, but they had failed because they lacked adequate equipment and training in farm management. These two needs the Farm Security Administration has endeavored to supply. Small loans are made to farm families, who cannot obtain credit from any other source, for the purchase of the minimum of equipment required to carry on farming operations. Careful supervision of farm- and home-management plans provides the training and guidance.

Rehabilitation loans finance the purchase of necessary farm supplies, livestock, seed, fertilizer, feed, tools, household equipment and temporary food and clothing requirements. They are repayable over a period of 1 to 5 years and carry a 5-percent interest rate.

Every farmer who accepts a loan agrees to follow a farm- and home-management plan, worked out in co-operation with the county rehabilitation supervisor and based on practices recommended by county agents and Extension Service experts.

A typical farm- and home-management plan calls, first of all, for the raising of enough vegetables and

¹ Administrator, Farm Security Administration.

livestock to meet the family's own subsistence needs. Acreage is set aside for the raising of feed for work animals and other livestock. The rest of the farm ordinarily is devoted to cash crops, which are diversified as much as possible. Throughout the year the rehabilitation supervisor is ready to give the borrower any additional advice he may require, on methods, soil protection, and crop rotation.

If the farmer is hopelessly burdened with debt, a voluntary committee of local citizens helps him to make an adjustment with his creditors, thus enabling him to get on a sounder financial footing.

When the farm is rented the Farm Security Administration tries to secure satisfactory leasing agreements which will give the tenant a sense of security and stability. This is not only desirable in itself, but also decreases the loan risk by assuring sufficient time for the working out of the farm plan.

There is a large group of destitute farmers who could not wisely be given rehabilitation loans, even if money were available. Thousands of families living in drought areas have been refused loans because their land did not contain enough moisture to justify planting a crop. Approximately 58,000 additional families have migrated from the Dust Bowl region to the Northwestern and Pacific Coast States. Many of these have settled on acreages too small or too barren to provide a permanent support. It would defeat the purpose of both the rehabilitation and land-planning programs to extend loans for permanent improvements on land that should not be kept in agricultural use. Under such circumstances and in cases of extreme need, the Farm Security Administration has therefore made subsistence grants rather than rehabilitation loans.

It is now generally recognized that there is an intimate relationship between our system of land tenure and such problems as soil erosion, occupancy of submarginal lands, and progressive impoverishment of the individual and community life.

Tenants with short-term verbal leases have at best a transitory interest in the land they cultivate. They are not penalized for letting the land decline in fertility, nor are they rewarded for any improvements they may make. Such people are likely to regard their farms as a resource to be exploited to the full during their brief occupancy, rather than as homes to be improved and made secure for the future. Unless the farmer has some security on the land, it is difficult, if not impossible, for him to cope with land-use problems.

In the South, particularly, where a live-at-home program and a more diversified type of farming appear

to be desirable, the present system of tenancy stands in the way of improvement.

Today more than two out of every five farmers in the United States are tenant farmers, tilling land they do not own. Their ranks are increasing rapidly, at the rate of about 40,000 a year. One tenant out of every three moves each year. In many areas, the result is a gradual impoverishment of landlords, tenants, and the land itself.

As one approach to the problem, Congress passed the Bankhead-Jones Farm Tenant Act. Title I of this act provides for loans to a limited number of tenants, croppers, and farm laborers for the purchase of their own land. The Farm Security Administration was designated to carry out this program.

Funds have been allotted to each State and Territory on the basis of farm population and the prevalence of farm tenancy. It is estimated that approximately 2,100 loans can be made in about 325 counties with the \$10,000,000 appropriated for this fiscal year.

County committees, consisting of three farmers, certify the applicants who by reason of character, ability, and experience are likely to carry out successfully the undertaking required under a loan to purchase a farm.

Loans are extended to selected farm tenant families for the purchase of a family-size farm. Such a farm in general is not larger than can be handled by the farmer's own labor and that of his family. The farm provides as much productive work as possible and should yield sufficient income to provide for the family on a satisfactory basis and enable the borrower to pay off the loan.

The farms selected are productive, and the productivity will be carefully maintained by a sound farm-management plan. These plans are prepared by the farmer with the help of the county supervisor. The assistance of specialists of the Extension Service, the College of Agriculture, and the experiment stations guarantees that the plans are in accordance with the best agricultural and home-management practices developed in each area.

The basis for the improvement of land use in the rehabilitation and tenancy programs is the farm-management plan, based on the best advice obtainable through county agents and State extension services. Studies made by these experts are applied to the individual farm, and crops best suited to that farm are planted and cultivated scientifically.

The purpose of the farm-management plan is to make the farmer self-sufficient in raising food for his family

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Water Facilities for the Arid and Semiarid West

By Dillon S. Myer¹ and L. C. Gray²

FOR many years the Federal Government has assisted in the development of large works for the use and control of water, but only recently has it given aid in providing small water facilities. Under the emergencies of recent years and the various attempts to relieve them, considerable Federal aid has been expended in the development of small water facilities in parts of the Great Plains. Many small reservoirs were constructed, but there is still need for much additional effort along this line. It is expected that the present program of the Department of Agriculture for the development of water facilities will round out the water-use projects in the arid and semi-arid Western States where the low and very irregular precipitation, combined with meager supplies of surface and ground water, constitute a problem that is of paramount importance to agriculture.

The extent of development in these arid and semi-arid areas is generally proportionate to the amount of available water. Where irrigation was practicable, stable communities have developed; but the relatively limited water supplies have restricted such development to a small area. The efficient use of the scant supply is, therefore, necessary to the sound use of the other resources of the region.

In much of the semiarid West crop production under dry-land farming conditions is highly uncertain. Years of drought as well as periods when precipitation is above average are not uncommon, and a tendency toward precipitation cycles of irregular duration seems apparent. During the periods of higher rainfall, dry-land crop production flourishes and is pushed farther into drier sections; but when the periods of lower rainfall recur the farmers find themselves in serious difficulties and blame their troubles to the lack of rainfall. Because of lack of stock-watering facilities parts of the range cannot be efficiently used for grazing even in years of average precipitation, and during drier periods the water-supply problem becomes acute.

Small water facilities of several types are needed to promote better land use and to assist in stabilizing agriculture in these arid and semiarid regions. On the range lands springs should be developed, wells should be dug where ground water is available at reasonable depths, and small impounding dams should be con-

structed to create water supplies for livestock. These facilities should be carefully located in order to serve the area adequately while avoiding the duplication of facilities in nearby places. During recent years the programs for construction of small livestock water reservoirs have not always been coordinated or accompanied by careful planning, and as a result many of the reservoirs are not properly serving the purpose for which they were intended.

To increase the amount of available forage in these arid regions, the storm waters and spring run-off from snow melt should be diverted from water courses and spread on pasture and hay lands; this would also aid, to a minor degree, in the mitigation of floods.

Water facilities may be used to assist, to some extent, in the stabilization of dry farming. On some farms adequate water is not available for domestic and livestock purposes. Where ground water is present it may be used as a source, but there are areas in which the supplies must be obtained from surface water. If an ample water supply can be secured, such facilities may be made a little larger so that they may be used for the production of an adequate home garden, a small amount of forage for work stock, and possibly the farmer may be able to keep a milk cow.

The purpose of the land utilization program of the Department of Agriculture under title III of the Farm Tenant Act is to relieve distress among farmers and to demonstrate how lands which are submarginal for their present use may be put to uses to which they are better suited. One of the methods used in the drier areas of the West is Federal purchase of submarginal crop lands and their development for range use. Development includes the provision of necessary livestock water facilities. The construction of water facilities in this program, however, is limited to federally owned lands.

On its demonstration projects and C. C. C. camp areas in the arid and semiarid sections of the country the Soil Conservation Service has included the development of water facilities as an essential part of a coordinated soil- and moisture-conservation program. It has recognized that without this necessary development of water facilities, a balanced farm or ranch program, capable of meeting the economic needs of the operator, would be seriously handicapped if not an actual impossibility over a long period of time. Efforts of this

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² Assistant Chief, for land utilization, Bureau of Agricultural Economics.

agency in the direction of better water facilities have been limited, however, to defined areas which do not encompass a majority of the farms and ranches seriously needing this type of assistance.

Federal assistance to individual farmers and ranchers in the development of water facilities on land which is not in Federal ownership has been made possible by the passage of the Pope-Jones Water Facilities Act.³ As funds are being provided for the program under this act, this assistance will be made available to farmers.

Specifically, the objective of the Pope-Jones Act is “* * * to assist in providing facilities for water storage and utilization in the arid and semiarid areas of the United States.” The Secretary of Agriculture is authorized “* * * to formulate and keep current a program of projects for the construction and maintenance in the said [arid and semiarid] areas of ponds, reservoirs, wells, check-dams, pumping installations, and other facilities for water storage or utilization, together with appurtenances to such facilities. The facilities to be included within such program shall be

located where they will promote the proper utilization of lands and no such facilities shall be located where they will encourage the cultivation of lands which are submarginal and which should be devoted to other uses in the public interest.”

These facilities may be located either on federally owned lands or “* * * on any other lands upon obtaining proper consent on the necessary rights or interests in such lands.” The land utilization program of the Department of Agriculture is rounded out by this authorization for the construction of water facilities on lands not owned by the Federal Government. From a standpoint of policy this act is especially significant in that it recognizes the relationship between water use and land use in the more arid parts of the country.

Before construction is undertaken in any area, attention will be given to the careful planning of necessary facilities to assure that they will promote better land use and demonstrate coordinated use of land and water resources. A further aim of this program is to provide adequate water facilities at costs commensurate with the benefits to be obtained from them.

³ Public No. 399, 75th Congress.



THE REHABILITATION AND TENANCY PROGRAMS

(Continued from p. 15)

and feed for his livestock. This requires a diversified program of garden and feed crops as well as a cash crop, and generally tends to reduce the acreage devoted to cash crops.

Both because of the undesirable effects of insecurity on the tenant and in order to insure the proper working out of the farm plan, the Farm Security Administration encourages written leases for as long a period as practicable for all farmers who receive rehabilitation loans. Only 20 percent of all tenants hold written leases, in contrast with 83 percent of tenants holding such leases who are rehabilitation clients.

This assurance of continued occupancy, with the guidance furnished by county supervisors, has thus far served to promote soil conservation and good land-use practices among rehabilitation borrowers throughout

the country. In the southern Great Plains area, the number of borrowers who adopted strip-cropping increased from 215 in 1935 to 2,381 at the end of 1937. Those who used contouring increased during the same period from 438 to 3,350. The number who have begun terracing their land rose from 85 to 612.

Increase among these families of the number of work animals and livestock owned is additional evidence of improved tenure status and improved farming practices. A recent study of 231,000 borrowers showed that they had doubled their ownership of work animals, and more than tripled the number of subsistence livestock.

The enlargement of the farm units to an economic size is yet another evidence of improved land use. This same study revealed that the average acreage cultivated by clients increased from 80 to 102 acres.

Flood Control Work of the Department

By Arthur C. Ringland¹

THE Flood Control Act which was approved June 22, 1936, is the enabling legislation which establishes the Federal policy in relation to a national flood-control program and the principles which are to govern actions of the Secretary of War and the Secretary of Agriculture in carrying out the work authorized. The implications and potentialities of this organic legislation mark it as of extraordinary significance in the field of conservation. It is the culmination of 30 years of effort initiated in Congress in 1907 by the late Senator Francis G. Newlands. To use the words of Secretary Wallace: "It presents to the Department a rather extraordinary opportunity to coordinate the efforts of Federal, State, and local agencies with those of thousands of farmers and other landowners. The problem is not one of techniques and economics alone, but also one involving fundamental social principles, including new forms of local social control. In fact, the problem is so comprehensive that we must draw upon the experience of many of the bureaus of the Department. I know this experience of coordination will be productive and it may even point the way to a broader application of this principle throughout the Department."

Senator Newlands contended that flood control was a national problem that demanded treatment of the entire river as a unit, from the very springs to the mouth. He emphasized that not only was the construction of levees and storage reservoirs necessary to obstruct the flow of floodwaters but that other devices through "scientific soil cultivation in such a way as to absorb instead of shedding moisture," would have to be employed and that forest areas must be increased to serve as natural reservoirs. To these ends he kept before succeeding Congresses a bill to establish a commission to develop waterways and watersheds for the complete use of water, and to correlate and coordinate all factors relating to flood control.

It was not until 1917 that the Newlands bill was passed and included as section 18 in the River and Harbor Act of August 8. The act was a compromise and provided for the appointment of a commission to be known as the Waterways Commission " * * * to bring into coordination and cooperation the engineering, scientific, and constructive services, bureaus, boards and commissions of the several Governmental

Departments * * * to study development or control of waterways and water resources and subjects related thereto * * * with a view to uniting such services in investigating, with respect to all watersheds in the United States, questions relating to the development, improvement, regulation, and control of navigation * * * including therein the related questions of irrigation, drainage, forestry, arid and swamp land reclamation, clarification of streams, regulation of flow, control of floods, utilization of water power, prevention of soil erosion and waste, storage and conservation of water for agricultural, industrial, municipal, and domestic uses * * * to secure the necessary data, and to formulate a report to Congress * * * a comprehensive plan or plans for the development of waterways and the water resources of the United States * * *."

President Wilson delayed the appointment of the Waterways Commission presumably because of the intervention of the World War. Section 18 of the River and Harbor Act of 1917 was repealed when the Federal Power Commission was created by the act of June 10, 1920.

For many years Federal control measures continued to be largely confined to the construction of levees along the lower reaches of the Mississippi River to confine the overflow of flood waters. Storage reservoirs did not become a factor in national flood control until the passage of the act of May 15, 1928. This legislation directed the War Department to prepare projects for flood control on all tributary streams of the Mississippi River system which were subject to destructive floods. The effect was to be attained by the establishment of a reservoir system in the drainage basins of the tributaries, and the benefits would accrue to navigation and agriculture through the prevention of erosion and silting of the streams.

In a series of reports, the Army Engineers projected a comprehensive flood-control plan involving many reservoirs and some 2,000 projects at an estimated cost of over 8 billion dollars. The reports increased the emphasis placed upon the value of the storage of floodwaters in addition to protection works such as levees and flood walls. The great floods of 1936 in the Connecticut, Susquehanna, Allegheny and Monongahela dramatized the legislative situation in Congress, and in May 1936, the Senate Commerce Committee pre-

¹ Chairman, Flood Control Coordinating Committee.

sented the remarkable flood-control measures which became the Omnibus Flood Control Act of June 22, 1936, and which recognized the complementary relations of biology and engineering in the control of floods.

Essentially, Congress recognizes under this act that the Federal Government in cooperation with the States and their political subdivisions, should undertake investigations and improvements of waterways, including the watersheds thereof, for flood-control purposes, if the benefits are in excess of the estimated costs and if lives and social security are affected. To further those principles Congress has provided that Federal investigations and improvements of waterways shall be prosecuted by the War Department, and that Federal investigations of watersheds and measures for run-off and waterflow retardation, including soil-erosion prevention on watersheds, shall be carried forward by the Department of Agriculture. The preliminary examinations and surveys already authorized, to determine the necessity for control measures and estimates of costs, now include the watersheds of all the major drainage basins of the United States. Under the authority of the Flood Control Act of 1938 further provision is made to correlate the program for the improvement of rivers and other waterways by the War Department with the program for the improvement of watersheds by the Department of Agriculture. Works and measures are now authorized to be prosecuted by the Department of Agriculture on the watersheds of waterways for which engineering works have been adopted and authorized to be prosecuted by the War Department. Moreover, the act of June 11, 1938, making appropriations for civil functions administered by the War Department, includes as part of the funds made available for flood control operations an initial \$4,000,000 for the prosecution of works and measures for run-off and waterflow retardation and soil erosion prevention on the watersheds of flood control projects authorized by law. This will permit the Department to proceed, as soon as survey plans are completed, with control operations upon certain watersheds of high flood hazard such as the Los Angeles, and carry out its work on such projects concurrently with the War Department.

The development of the national flood-control program projected by Congress involves the correlation of the plans of the War Department and of the Department of Agriculture. Economically, a flood-control plan must rest upon the direct benefits which it bestows upon the protected areas. Major engineering flood-control structures such as storage or detention reservoirs, debris basins, flood walls, and levees are immediately operative in the protection afforded to

lives and property. It is therefore a responsibility of the Department of Agriculture to determine the upstream auxiliary measures necessary to complement these downstream engineering works; to increase the effectiveness of the flood-storage capacity of the reservoirs by the retardation of run-off and decrease the rate of siltation; and through the control of tributaries to reduce the shoaling of river channels protected by levees and revetments.

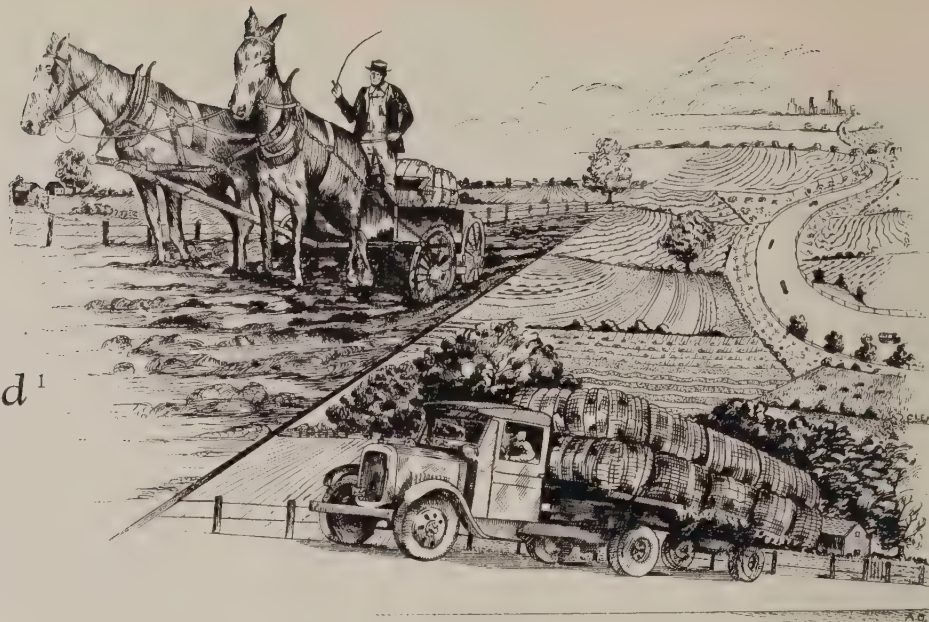
These upstream measures, however, are to be distinguished from the land-use adjustment programs of the Department, although some of the techniques employed may be similar. Upstream flood-control measures are directed to the control of flood flows and the stabilization of soils of headwater areas for the protection of existing values downstream. Land-use programs are directed to the better use of farm, range, and forest soils for the maintenance of a permanent agriculture. Each class of work creates a distinct kind of Federal and local relationship. Each requires a particular organization, distribution of costs, and obligations of maintenance. Each can be integrated to further a common program.

The flood-control program is a coordinated enterprise of a number of bureaus in order to carry out adequately the responsibilities of the Department. Advisory and coordinating committees have been set up to formulate policies, establish procedures, and provide for cooperation and collaboration between bureaus. At the same time coordinating committees have been organized in the field representing the Bureau of Agricultural Economics, the Soil Conservation Service, and the Forest Service, comparable to the Flood Control Coordinating Committee in Washington. Additionally, representatives of other bureaus have named consultants in Washington and in the field to assist these committees.

The task ahead is as vast as is the country, for it may be assumed that the cost of watershed control will equal the cost of waterway improvement. The problem presented is not so much one of techniques of control as it is of organization and finance. The responsibility for upstream control must be discharged adequately and within a reasonable time if effective results are to accrue, and in the case of some watersheds to prevent damage beyond the bounds of economic recovery. These considerations, and Federal and State budgetary limitations, suggest that in addition to appropriations, loans, or local cooperation, other forms of assistance should be considered, including W. P. A. and C. C. C. labor, if upstream control is to be developed concurrently with downstream control and at a cost commensurate with other national obligations.

Roads to Market

By. T. H. MacDonald¹



IT IS almost self-evident that highway transportation is closely associated with the use of land. In many areas, the highway offers the only means of transportation, while in others it is a very important if not the essential link with other forms of transportation. Consequently, highway development should be closely coordinated with programs for proper land utilization. Highways intended to serve primarily agricultural needs should not be developed in areas which are going out of agriculture or which should be withdrawn from agriculture. Conversely, the highway program may be used in conjunction with other appropriate measures, such as land acquisition, rural zoning, etc., to induce proper use of land: Through the withholding of highway improvements in areas unsuitable for agriculture, and by assisting the development of true agricultural communities through the provision of favorable highway facilities, it is possible to discourage continued use of submarginal lands and to further in no small degree the program of agricultural readjustment.

The Department's highway program has been developed to keep pace with the changing conditions of a transitional period of remarkable transportation development. It may be broadly described as covering three periods, differentiated by the methods used in selecting highway projects.

The first period began in 1893. During the late eighties, the National Grange and the League of American Wheelmen had stirred up sufficient interest in highways to bring about the establishment by Congress of a new office in the Department, the United States Office of Road Inquiry. The Office of Road Inquiry studied road building materials and methods, published reports, and built object-lesson roads, often in cooperation with land-grant colleges

as a phase of the Federal aid granted to such institutions by the Morrell Act.

Before the end of this period, the American automobile industry had begun its phenomenal growth. By 1916 the demands of automobile owners for roads on which they could make longer trips had become a powerful pressure, and rural landowners were urgently demanding better roads to markets.

In 1916 the Federal Aid Road Act was passed. In addition to granting Federal aid, it provided for the organization of State highway departments. It did not, however, prevent expenditure of the appropriations made under it on many disconnected projects. During the next 5 years, which included the War and a tremendous increase in agricultural production and in highway transport, the need for development of a highway system became urgent.

The Highway Act of 1921 provided for the next logical step—the concentration of Federal aid expenditures on through roads and trunk lines not exceeding 7 percent of the road mileage in any State. It immediately became obvious that the first essential in developing a system of highways was a framework upon which the structure could be built, and thus began the period of selection. It was not difficult for the States to select the most important through routes; an intelligent study of the map was all that was required.

As the task of connecting all the States and their important centers was carried forward, other economic changes appeared on the horizon. One of these was wide-spread hand-to-mouth buying, which rapidly replaced the old system wherein business houses had carried large stocks. As new highways augmented the transportation net, other marketing practices changed also. Rural landowners—as for example, cotton growers operating trucks—could hold their crops

¹ Chief, Bureau of Public Roads.

for a favorable price and still get them to market in time to realize a suitable return. The farmer's neighborhood grew larger, as did the area in which he could market his crop, and the more he enjoyed the benefit of roads, the more urgent became his demand for extension of Federal aid to so-called farm-to-market roads.

By 1935, the Federal highway system was practically complete in its first development. Every important center in the country had been tied into the net, which in the more prosperous and densely populated States had been woven closer with State roads. The pressure from rural landowners for better roads to market was still increasing. The necessity for relief for unemployment growing out of the depression required the expenditure of Federal funds, and provision was made, for the first time, through the Hayden-Cartwright Act, for expenditures from such funds on secondary roads. The selection was to be made from 2 million miles of local roads. Little was known as to the condition of these local roads, and it was apparent that a thorough fact-finding survey would have to be conducted before it would be possible to select from this vast mileage the roads which should be added to the State highway systems. This necessity had been recognized by the Congress in the Hayden-Cartwright Act of 1934, which authorized the use of 1½ percent of the Federal-aid highway funds for such surveys. Under this pro-

vision, the highway departments of 43 States are now cooperating with the Bureau of Public Roads in a series of comprehensive state-wide highway planning surveys.

Other reasons existed also for the state-wide highway planning surveys, which began in 1935 and opened the period of scientific selection. The volume and type of highway traffic had been changing since 1921. Vehicles were heavier and faster, and there were a great many more of them. Highways satisfactory for the speeds of 15 years ago are hazardous today, and there is consequently the problem of reconstructing and modernizing a large mileage of the primary system. In the consideration of a secondary system, therefore, one of the most important problems is the financial problem. A determination must be made of the total amount necessary to improve a logical and needed mileage of local roads, and at the same time to protect the investment already made in the primary system.

It is in the selection of the secondary or local road system that the Department's highway program can be of greatest assistance to, and receive the greatest benefit from, other land-use programs of the Department. The Bureau of Public Roads, and in fact all highway builders, will be vitally interested in a coordinated series of land-use or land-classification studies.

ECOLOGY OF MIXED PRAIRIE IN WEST CENTRAL KANSAS. By F. W. Albertson. University of Nebraska. October 1937.

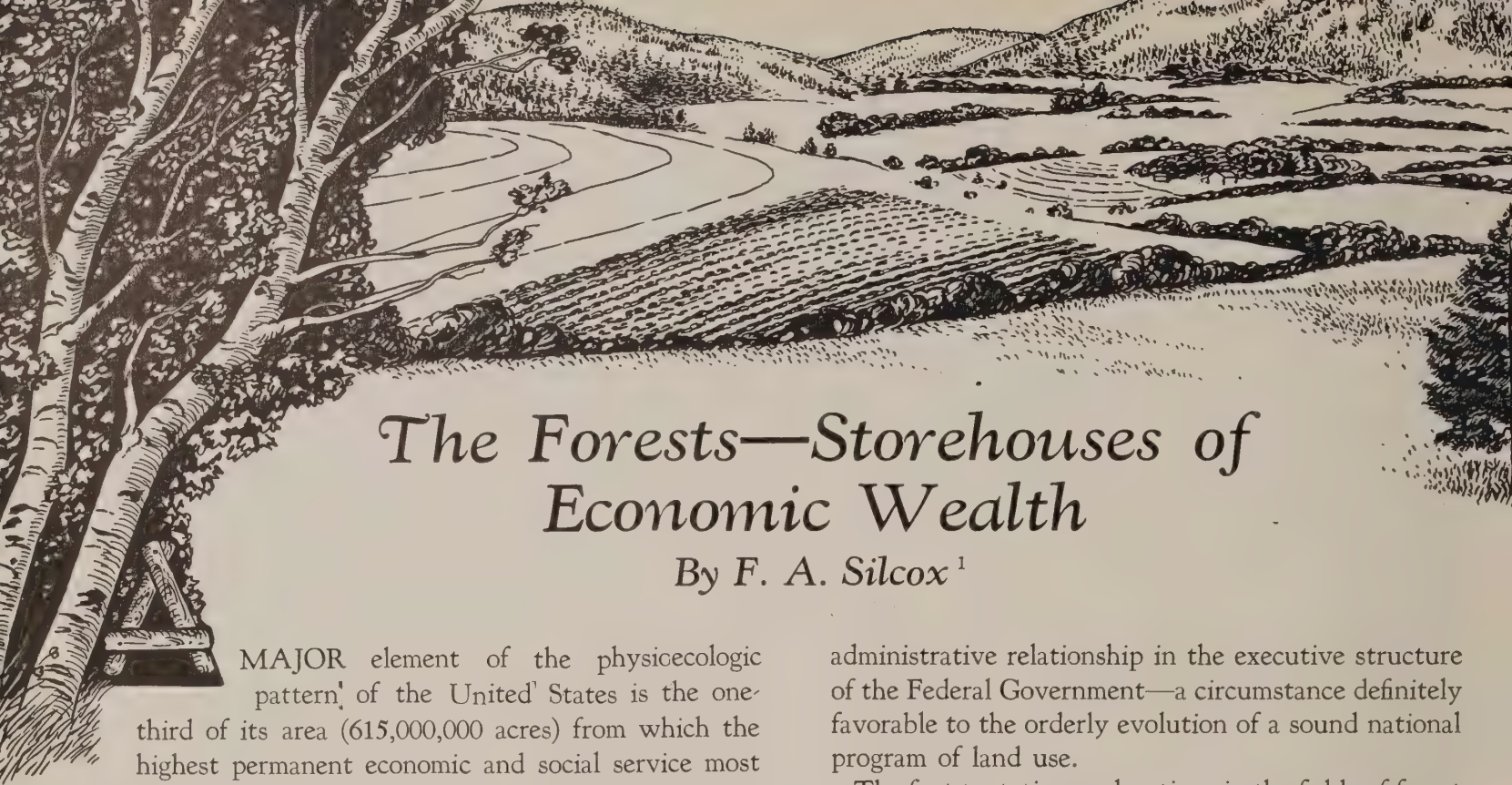
The mixed prairie treated in this work as a distinct plant association occupies a broad belt across the western half of Kansas where the topography is rolling and precipitation is extremely variable. Because of its proximity to the Dust Bowl, the area holds much interest for the conservationist and this study, which supplements the investigations of Weaver and Clements, Pool, Bruner, Shantz, Aldous, Schaffner, and others on grassland associations and environment, will be welcomed by all who realize that ecological studies are necessary for a true understanding of plains and prairie problems.

The research from which data were assembled was concerned with the detailed structure of several types of mixed-prairie grassland, the reasons for their distribution, interrelations of the plants both above and below ground, and measurements of the soil and aerial environmental factors. The unit area studied comprises 750 acres of land which since 1900 has been fenced and only lightly grazed. The field studies were made during a 3-year drought period. Climate and soils are described, and results of run-off, percolation and evaporation investigations in the short grass, little bluestem and big bluestem habitats are given introductory to the main problem involving the plant community relationships.

The studies on the vegetation have an especial value as pointing out the shiftings in plant populations with varying precipitation

and soil-moisture supplies, and the relationship between depth of rooting and resistance to drought among several related species. It was found that *Bulbilis dactyloides* and *Bouteloua gracilis* comprise about 80 percent of the short-grass cover, with early spring growth producing a dense sod, and early blossoming and fruiting. There is rapid recovery after drought, with buffalo grass leading in the reclaiming of bared areas from which certain native forbs entirely disappeared. Root penetration of buffalo grass and blue grama was found to be about 5 feet. In the little bluestem areas, on the steep hillsides, *Andropogon scoparius* is the dominant species; and here "a greater number of species and better developed societies of forbs occur . . . than in either the drier short-grass habitat or the less xeric lowland dominated by tall sod-forming grasses." In the little bluestem habitat the dominant species and certain other grasses have root penetration of three or more feet, while some of the long-lived forbs extend their roots 4 to 6 feet into the soil of south slopes and 6 to 12 feet in deeper soils of north-facing slopes. In depressions well supplied with moisture, *Andropogon furcatus* is the dominant species, and with other sod-forming grasses it forms an almost continuous cover. During the drought period *Agropyron smithii* increased greatly in the big bluestem community.

The grasses and forbs constituting the three principal communities are listed in three separate tables, and excellent drawings show quadrat findings. Drawings illustrating growth below ground of many of the plants are included, and these are most illuminating in connection with the discussions of ecological relationships in the separate communities.—P. O'N. F.



The Forests—Storehouses of Economic Wealth

By F. A. Silcox¹

MAJOR element of the physicecologic pattern¹ of the United States is the one-third of its area (615,000,000 acres) from which the highest permanent economic and social service most effectively can be derived through the media of forests. They are vital parts of the complex mechanism of nature—essential factors in the processes through which is maintained the ecological equilibrium to which the American people have adapted their cultures, their social and industrial economies and, particularly, their agricultural techniques. Agriculture is dependent upon favorable climatic influences, stability of stream flow, retardation of abnormal soil movement, readily obtainable and inexpensive supplies of fuel and building materials, local markets for farm products created by local industrial development, markets for surplus farm labor and equipment through the conversion of raw materials into commodities of utility and commerce. To all of these needs of agriculture the forests of the United States make large and definite contributions. Opinions may vary as to the exact measure of these contributions, but it is an indubitable fact that even in their minimum proportions they collectively influence much of the agricultural economy of the Nation.

Thus it was logical that the first Federal agent appointed to study forest conditions in the United States, in 1876, should be employed in the Department of Agriculture; that the Division of Forestry organized in 1881 should have been a unit of that Department; that the more pretentious Bureau of Forestry created in 1901 should continue in that Department; that the administration of all the national forests should be assigned to it in 1905. The intimacy of relationship between farming and forestry, which exists in fact, fortunately has been paralleled by

administrative relationship in the executive structure of the Federal Government—a circumstance definitely favorable to the orderly evolution of a sound national program of land use.

The first tentative explorations in the fields of forest biology and economy disclosed trends which, if allowed to continue unchecked, threatened eventually to have an adverse effect upon the national welfare. At that time, the United States still possessed a tremendous acreage of virgin forest land. Hence, a logical initial step was to safeguard the public interest in those properties by the passage of the act of March 3, 1891, which authorized the withdrawal of public lands as forest reserves, later to be known as national forests. Constructive basic principles for the permanent management of these public properties were developed in the act of June 4, 1897. To both of these movements the Department of Agriculture made large contributions, but because the lands were parts of the public domain their administration was vested in the Department of the Interior. The technical and scientific aspects of forestry were functions of the Department of Agriculture. In recognition of the inseparability of the two functions, Congress, by the act of February 1, 1905, consolidated them in the Department of Agriculture.

Due to its initial impetus, the development of a Federal system of public forests has progressed with marked success. While reservations of public lands largely met the situation in the Western States, it failed to meet the urgent requirements in the States in which the public domain largely or wholly had passed to private or State ownership. A policy of acquiring forest lands by purchase consequently was inaugurated by the act of March 1, 1911, and extended by the act of June 7, 1924. Through these various developments there now exists, distributed throughout 38 of the States, Alaska, and Puerto Rico, a system

¹ Chief, Forest Service.

of national forests comprising 157 units of administration. Their boundaries embrace a gross area of 226,621,123 acres, of which 174,405,397 acres are owned or in course of acquisition by the United States. Of the total land area of the 48 States, 8 percent is now national-forest land, and the entire acreage within the forest boundaries benefits from their protection, development, and management.

These national forests are administered under the principles of balanced and controlled utilization, through which they serve a wide array of social, industrial, and economic needs. Several specific types of service may be enjoyed simultaneously or consecutively, from the same lands. Through restoration of optimum forests and vegetative covers there is derived concurrently with timber production the stabilization of run-off, retardation of abnormal soil movement, forage production, conditions favorable to the propagation of wild-life, wide opportunity for outdoor forms of recreation.

These vast storehouses of economic wealth are in active use. From them is cut the equivalent of more than one billion board feet of timber each year, yielding revenues of \$2,500,000 to \$3,000,000. Cattle and horses numbering more than 1,300,000 head, sheep numbering 5,637,000, plus their young, are grazed by 26,000 permittees who pay the Government over \$1,500,000 yearly. More than 1½ million game animals find their habitat in the national forests. Over 60,000 miles of stream produce fish. More than 40,000 areas are occupied under permit for purposes of industry, commerce, recreation, and public service from which annual revenues exceed \$400,000. From the watersheds of the national forests hundreds of cities, towns, and irrigation districts draw much or all of the water supplies vital to their existence. These uses represent not the substance but the increment; they are not ephemeral but indefinitely repeatable.

The nature and distribution of the national forests brings them into a certain coincidence with the majority of the farming regions which are preponderantly submarginal, but from which flows the youth that makes up the deficiencies of urban populations. Within or adjacent to the national forests are several hundred thousand families whose economic destinies are linked with the depleted soils and resources resulting from decades of natural resource exploitation. These people cannot be transplanted to other locations; their economic salvation lies in their rehabilitation in their present locations. Part of the program of rehabilitation is economic: it involves the restoration of industries through replacement of natural resources, the development of credit facilities, and the organization of marketing arrangements. Part is the rehabilitation of the home—a sanitary rather than a polluted water

supply, a tight roof rather than a leaky one, firm foundations instead of rotting sills. Part is a matter of education through Extension Service leadership.

In these circumstances, national-forest management is not a relatively restricted function of natural resource production and utilization, but rather a widely ramified process of economic and social planning in which the human factors largely are dominant. Management as a foundation for acceptable ways of life for dependent people, in fact as means of life, is the paramount objective of national-forest administration. Early recognition of this ideal inspired the first notable example of large-scale planning of nonurban land uses. Only by careful planning and correlation could the protection of the forests, the structure of physical improvements essential to their effective use, the adjustment of competitive economic demands for the industrial use of their material resources, the provision for wildlife, the safeguarding of esthetic, inspirational and scenic qualities, all be harmonized into mutually compatible patterns. Thus it happened that, of sheer necessity, the Forest Service was the first of the Federal agencies to give widespread application to principles of planned land use. Such planning is never static; it is a continuing process requiring constant readjustment.

In not only public but also private forest management, the fundamental need is for scientifically determined knowledge as the basis for both planning and action. A second major field is therefore that of forest research, which in itself constitutes a current action program of vast proportions.

The areas of forest land in private and State ownership occupy a leading position in the country's forest ownership pattern because of their location, values, and productivity. They comprise more than 70 percent of the country's forest area. They contain the best four-fifths of the commercial forest lands and the best three-fifths of the present commercial sawtimber stand. About 98 percent of all forest products are now cut from them and nine-tenths of all potential forest growth is on them.

The forest drain exceeded forest growth by about two to one in all sizes and about five to one in sawtimber sizes from 1925 to 1929. It is not now so great, but the actual and potential economic loss has been staggering, and the observance of social values largely neglected. Uncontrolled and wasteful utilization practices that do not contribute to economic and social stability are detrimental to the public interest. The handling of wood as a crop is paramount, the conservation and perpetuation of the forest resource mandatory if we are to have a continuous supply of needed forest products. Other uses, as for recreation, flood and erosion control, etc., naturally follow.

The Forest Service, as the acknowledged Federal leader in continuously productive use of forest land, has established working relations with forest producing agencies, and has carried on the work of developing a unified approach to the solution of the problem. Critical cases have been analyzed, recommendations made to interested public agencies, landowners and industries, and steps taken to secure remedial action. Working in harmony with cooperating governmental agencies, State forestry agencies, and representatives of the wood-producing and wood-using industries, plans have been laid, and in some cases placed in operation, to secure and study the data essential to presentation of the full-vision picture of forest-land use, for the various economic operating areas and for certain States as a whole. Preliminary records indicate that some 37 million acres of industrially owned forest lands are now under some form of forest management, of which from one-fifth to one-fourth may be considered under sustained yield.

The pulpwood situation in the Southern States has presented a definite and categorical example of Federal leadership in safeguarding the public's interest in the forest resource. Unprecedented expansion in the kraft industry, the influx of more than 100 million dollars in increased pulp-industry investments in that area, with the attendant threat of despoliation and devastation, made it imperative that cautionary action be taken. Cooperating with the Forest Service the southern division of the American Pulpwood Association is engaged in a program of self-regulation which it is hoped may lead to a dual goal of protecting the industry's investment and the stabilized production of the timber crop, a major portion of which comes from the farm woodlands of the South.

Forestry on the farm has also reached the cross roads. Closely integrated with agriculture, the tree crop gives to the farmer an opportunity to receive periodic financial dividends from the poorer portions of his farmland. A continuously productive stand of timber on his hillsides and poorer soils is a "back-log" of security, and a major factor in the stabilization of his farm life. The Forest Service has long recognized the importance of the forest crop on farms and of the need for a source of reasonably priced forest planting stock for woodlot, windbreak and reforestation plantings on farms, and has been cooperating since 1926 with the States and Territories, under section 4 of the Clarke-McNary Law, in the production and distribution of trees for such plantings. During 1937, 42 States and Territories cooperated in furnishing a total of 41,698,016 trees to farmers under this program alone, the trees being made available for the most part at a price slightly below the cost of production or procurement.

The trees furnished under the Clarke-McNary program meet only a fractional part of the farmers' demands. The expansion of the pulpwood industry

in the South and the resulting trend from a cotton to a wood economy in that region is reflected by a tremendous increase in demands for suitable planting stock.

The acute southern situation, coupled with others equally as important but possibly less dramatic in other sections of the country, resulted in the enactment, by the Seventy-fifth Congress, of the Norris-Doxey law, known as the Cooperative Farm Forestry Act. Vitalization of this law through appropriations will bring expanded programs of planting stock production to help meet the large unfilled farmer demand, and educational and service programs to assist farmers in the management of their forest plantations and woodlands. In harvesting their tree crops farmers need information and guidance in formulating plans for the efficient operation of their farmwoods so that cutting may be done lightly and frequently to provide steady income and to keep the land in continuous production. Much study has been and is being given to the adaptability of farm cooperatives in this field.

The need for large-scale field protective plantings in the prairie-plains region which would protect crops from being blasted by critical hot winds, protect livestock and keep light soils from blowing, was emphasized by recent severe drought conditions. Shelterbelt plantings of trees were first established under the plains-shelterbelt project, created by Presidential Executive order, and these have served to demonstrate the feasibility of such a solution to the problem. Since July 1, 1936, the field protective plantings in this region, established cooperatively with individual farmers, have been carried on as a work relief project. Approximately 44 million trees were planted up to October 1, 1937, of which about 70 percent are established and growing. Nearly 40,000,000 more have been planted this spring. Many of the trees, less than 3 years in the field, are over 25 feet tall, and 1935 plantings are already creating barriers which tame the winds that blow unrestrainedly across unprotected fields.

Continuous progress has been made in cooperative forest-fire prevention work, carried on cooperatively with the State forestry agencies in the individual States under section 2 of the Clarke-McNary law. Thirty-nine States and one Territory are actively participating in the program, with some degree of organized protection given to more than 250 million acres of State and privately owned forest land, resulting in only 1.07 percent of the protected area being burned over in 1936.

The need for increased State ownership of forest areas has been recognized by the passage of the Fulmer Act, authorizing purchase of forest lands for administration as State forests, and the program of management of resettlement areas, many of which have been transferred to State forestry agencies for administration.

The Land and the Birds and Animals

By Ira N. Gabrielson¹



THE greatest present need of American wildlife is for land. Any successful restoration program is fundamentally one of land utilization. Wildlife flourished on the North American Continent until the white settlers began to appropriate its native ranges. Although the aborigines lived principally on fish, game, and uncultivated native plants, they never caused any permanent injury to the resource. This was because their simple agricultural operations did not influence natural water levels and did not change or destroy the natural vegetation that provided food and cover for the wild creatures and also protected the soil. The white race, impelled by the necessity to increase food supplies for the support of a much larger population, began at once the exploitation of the soil, with results disastrous to wildlife and in many instances to the human population as well.

The wildlife restoration program of the Biological Survey takes into account the obvious fact that not all forms of wildlife can ever by any possible means be restored to primitive abundance. It does assume, however, that the resource can be greatly increased beyond the existing supply by the application of a sound policy of land utilization, and that the establishment of refuges need not interfere with agricultural development.

The existing national wildlife refuges fall into three general classes: (1) Waterfowl or general wildlife

refuges; (2) big-game refuges, preserves, or ranges; and (3) special refuges, or rookeries, for colonial non-game birds.

At the present time some 11,500,000 acres of land have been withdrawn by one means or another for the purposes of increasing valuable forms of wildlife. A major part of this total acreage is made up of lands that are submarginal in character. On much of it agricultural enterprises have been undertaken in the past, with little or no success but with definite injury to the soil and its protective covering. Drainage operations have damaged water levels not only locally but over wide areas of adjacent land. Soil erosion has occurred also as a direct result of this misuse. Many other evils of which we now complain spring from the same cause. Although the work of improving and restoring the areas now included in the Biological Survey's projects is still far from complete, it has progressed far enough to indicate that the policy is sound and feasible in every aspect.

When an area has been acquired, the administrator's first concern generally is to repair the natural hydraulic system and restore or raise the original water levels. This is in line with the efforts of every agency, Federal or otherwise, that is engaged in the conservation of the organic resources of the land—the soil itself and all its products. It represents a complete reversal of an earlier determination to get water off the land as completely and as expeditiously as possible. Hydraulic engineers are now concerned with finding means to keep water on the land and retard the run-off and drainage whenever possible.

Following the restoration of the water resources of an area an effort is made to regenerate the original vegetative cover. Where the vegetation has disappeared the area is replanted, and in many instances additional food and cover plants are introduced. Much

¹ Chief, Bureau of Biological Survey.



of this vegetation is of types that do not require a highly fertile soil. Many plant species that are valuable as soil binders, and also supply food and cover for wildlife, can be grown upon land too poor to yield a profit from any agricultural crop.



It will be noted that the operations just described are identical with the practices recommended by the Soil Conservation Service for projects having to do with the restoration of submarginal lands and the prevention of erosion. There are few, if any, instances where the work of the Soil Conservation Service has not produced conditions highly beneficial to the various forms of wildlife; and there is no single instance where the Biological Survey in carrying out the waterfowl restoration program has failed to promote the soil conservation program as well as its own. Even though there had been an unimaginable state of hostility and lack of sympathy between the Biological Survey and other land-utilization services of the Department, many of the benefits accruing to one service as a result of the operations of another could scarcely be prevented. Since on the contrary there is manifest among these agencies the warmest sympathy and willingness to cooperate, all programs have profited to the fullest extent possible.

While the Survey cannot ignore any opportunity to obtain large areas for restoration, preferably those that have been drained, it is none the less interested in regenerating any area, large or small, particularly in the North Central States. The Survey has received a great deal of cooperation from various Federal agencies and from some State agencies in improving small water-restoration areas. The Soil Conservation Service has built hundreds of small reservoirs and ponds; others have been built by the Forest Service and the Interior Department's Grazing Service; and the Biological Survey itself has constructed a great many. Where these can be fenced and protected from livestock trampling, every small reservoir and dam becomes a fine duck-nesting area, and every little pool produces one or more broods of birds. It seems to be a good practice to fence these ponds and allow the stock to drink from troughs, or to fence lanes into the water, rather than needlessly to allow the destruction of the vegetation.

The easement refuges represent an interesting development in the Great Plains drought area. Here the

Biological Survey has obtained permanent easements from the farmers, which give the Bureau the right to flood the land and maintain each area as a migratory waterfowl refuge. In return for that the Survey does the work of restoring the water level and in most cases allows stock access to the water by one means or another. In North Dakota alone some 120,000 to 130,000 acres of land have thus been obtained, and the restoration of water levels is well under way. The easement program has since been extended to other States. It is one way of enabling the Government to develop minor wildlife areas at low cost.



The Survey believes that the principal and perhaps the only Federal responsibility toward nonmigratory and big-game species is to provide, within their natural ranges, Federal refuges for seed stock for every major North American wildlife species. From these reserves stocks may be drawn to restore the species in sections from which they have been extirpated. With the addition of three areas now under consideration, and a few others in the West for more specialized purposes, the big-game problem in the regions will be less urgent. In the Mississippi Valley there is no Federal big-game preserve, and it is desirable that the native ecological types be protected by restoring habitat and stock in at least one or two places.



It is estimated that about 7,500,000 acres of marshland, properly distributed throughout the breeding and wintering grounds in the United States, are needed to meet the minimum essential requirements of the migratory waterfowl. At the present time about 3 million acres are required to complete this part of the Survey's program.

The Pittman-Robertson Act, passed by the Seventy-fifth Congress, will in time have much influence in solving land-utilization problems in ways beneficial to wildlife, to forestry and to soil and water conservation. The act, also known by the descriptive title—Federal Aid to Wildlife Restoration Act—authorizes the appropriation annually of funds equal to the sums received from the 10-percent excise on arms and ammu-

(Continued on p. 28)



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



CONSERVING CORN BELT SOIL. By Glenn K. Rule. In Collaboration with Subject-Matter Specialists of the Soil Conservation Service. U. S.

Department of Agriculture Farmers' Bulletin 1795. November 1937.

In this well-constructed and lucid discussion Mr. Rule shows the cause and extent of productivity decline through soil and humus losses over 70 years of continuous cropping in the Corn Belt, and what can be and is being done to check such losses. Judging from the data given, this great area, 8 percent of the total United States, producing one-fourth of the cattle, one-third of the horses, two-thirds of the corn, with a surplus of meat and milk, must be so treated in the immediate future that further destruction will be prevented while at the same time operators may have subsistence from the land. Extending into four regions of the Soil Conservation Service, the area is of profound importance to conservationists if farmer and consumer interests are to be safeguarded through ever-normal production.

Some especially apt examples are given, among them the story of humus depletion under 40 years of drainage and cropping in the Old Black Swamp area in northwestern Ohio. Data from erosion experiments carried out at different stations throughout the Corn Belt show that leaching, humus depletion, and erosion in the region are due to cultivation of unprotected slopes in areas of intense rainfall, crop removal through marketing of plant and livestock produce in areas of fine-textured soils or soils with impervious subsoils, and denudation in those areas which are subject to wind erosion.

To prevent further decline in productivity in the Corn Belt the following recommendations are offered: Retire more erodible land to grass and timber; less corn, more sod crops and legumes; pastures for income; woodlots for income; soil conservation methods applied wherever needed to stop erosion and humus depletion of tillable land.

Better cropping systems are urged for the Corn Belt. "Probably the most important single step that Corn Belt farmers can employ in erosion control is to establish and maintain a satisfactory rotation of crops." It is suggested, however, that complementary treatments be applied—limestone applications to grow legumes for the correction of acid soils, the use of contour farming, grassed waterways, and strip cropping with the thick-growing crop below the row crop. An interesting chart shows how strip cropping may be started in a slightly sloping field. Buffer strip cropping is stressed as having marked possibilities for erosion control in the Corn Belt; it is suggested that permanent meadow strips 18 to 20 feet wide between strips of corn or other crop may be effective in preventing soil washing and at the same time mitigate damage from chinch-bug infestation, grasshopper attacks or damage to corn from hot winds. For cover crops in the vast Corn Belt area, rye, winter wheat, winter barley, and clovers and vetch are recommended, and Korean lespedeza where it is adapted.

Terracing for cultivation on 8- to 12-percent slopes in the Corn Belt is treated in some detail, with specifications for grade of terrace, spacing between terraces, construction and maintenance of adequate terrace outlets, and maintenance repairs. The proper procedure for plowing terraced land is described and illustrated by a drawing.

Mr. Rule states that in the Corn Belt, as elsewhere, prompt action against gullying, both preventive and remedial, is badly needed. Erosion control is of course the approved preventive measure; and to stop incipient gullying—sod bag dams, brush or loose rock dams, grassed waterways (with water diverted while seeding is being done.) In the control of large gullies in the area, diversion ditches should be provided to carry the water around the head, steep banks should be sloped, good soil should be thrown in, temporary structures of wire, post, rock, or log should be built to obstruct flow and catch soil, and then revegetation. For Corn Belt gullies, bluegrass, brome, Reed canary are suggested, while among the favored trees are green ash and white ash, black locust, the oaks, spruces and pines; and wild plum, bush dogwood, grape, wild cherry, haws, and coral berry among the shrubs. Black locust is pointed out as particularly advantageous because of its extensive root system, because it is a legume and adds nitrogen to the soil, because it promotes the growth of grass, and because its growth is so rapid as to produce posts in 10 to 15 years. Although black locust tends to spread, it can be checked by surrounding it with other tree species.

Permanent pasture improvement is stressed as important in the Corn Belt and recommendations are given for liming sour pasture soils and for controlling grub in infested upland pastures. Improvement of grazed and burned woodlands is urged also—keep out the livestock, prevent fire, employ thinning and planting where needed.

In the final section of his bulletin, under the heading "Joined Forces to Hold Soil," Mr. Rule presents brief descriptions of the West Tarkio River project, the Indian Creek project, and a single typical farm of each as rearranged provide for erosion control. As examples of the coordinated application of numerous soil conservation measures through farmer cooperation with the Service, these project outlines are particularly pointed and appropriate.

GERMAN FORESTRY. By Franz Heske. Yale University and Oxford University. 1938.

Here is a book that was written especially for those of us in the United States who are concerned with the curbing of forest exploitation and are looking forward to a national economy of land occupation and use which will eliminate in so far as possible the destruction of the land's productive capacity. One of the best features of the large volume is the historical interpretation of forest problems: it is most satisfying to the reader to know how through the centuries it all came about—the artificiality of forest growth in present-day German States, the shifting of species to suit economic conditions, the extermination of many other species, and finally the highly systematized development wherein all forms of land ownership favor the sustained-yield of forests necessary to the life of a country whose policy is population increase and whose land area already is inadequate.

Dr. Heske tells the story well and with detail, using appropriate and carefully prepared data to show the effect of various types of ownership upon improvement and depletion of forests on lands occupied by the German people for many centuries. From the first great clearings more than a thousand years ago, with creeping destruction about the settlements in mountainous regions, through the crucial period leading up to wood famine crises and



BOOK REVIEWS AND ABSTRACTS

Continued



subsequent restrictions and regulating laws—the beginning of silviculture—we are told of the struggle for a sustained-yield forest management policy which today cherishes the soil and the very life of Germany.

Many scientists and economists are of the opinion that in spite of great differences, inherent and environmental, between the United States and Germany, there are important lessons to be learned by the former from the latter's experiences in forestry, especially those of the past century. Dr. Heske warns particularly against the danger of slipping into schematic forms of forest structure during the transition from virgin forests, or from forests which have been subject to unrestricted exploitation to forests under sustained-yield management. Extensive monocultural plantings of industrial timber species, during the past 50 years, in many parts of Germany, proved beyond dispute the importance of the biologic factor in the health of the continuous forests. "Sooner or later," we are told by the author, "they [even-aged plantings of single species] showed serious defects, such as soil deterioration and decreased rate of growth, lessened resistance to animal and plant parasites, and increased liability to injuries from snow, hoarfrost, and wind." While in the beginning such growth was profitable in money income, it was found that in the long run it did not pay and was in direct opposition to the ideal of sustained management in accordance with the long-time interests of the people as a whole. It is to the work and writings of Johann Christian Karl Gayer, leader of the Back to Nature school of thought, that Dr. Heske attributes the development during recent decades of the naturally functioning and harmonious forest entity.

And fortunate it is for Germany that Karl Gayer lived and that his school of thought was taken up by others and carried forward to form the principal foundations of modern forest management in the German States. As expressed by Dr. Heske, the ideal demands "* * * that the forest be treated in accordance with biological laws, i. e.; mixed forest instead of the schematic culture of pure stands; retention of the soil-improving broadleaf species, especially beech; natural regeneration instead of clear-cutting with artificial seeding and planting; and uneven-aged form of forest in place of the forest composed of schematically arranged even-aged stands." It is of the area, distribution, and composition of present-day German cultivated forests that the main body of Dr. Heske's book treats. Species distribution is described by regions; and the many types of forest ownership, with their economic aspects, are traced throughout the centuries, from the communal woods of very early days to the present time. A very thorough analysis of forest management policies is included, showing the advantages and disadvantages of the many principles involved—size of acreage, ownership, entailment, jurisdiction, the structure of the sustained-yield forest, products of forests, employment in forests and associated industries.

Under the heading Indirect Benefits of the Forest is to be found a most interesting discussion of forests and the microclimate and the significance of new investigations in this subject in clarifying future forest policies. In this connection also are included historical analyses of forests and water supplies, the cultural value of forests, the chase, and the importance of the natural treatment of every forest in the land rather than the segregation of special wilderness areas for the satisfaction of the cultural and aesthetic ideal.

The second part of the book swings directly into a detailed description of the organization of German forestry of the present day. The functions of the various agencies and chief forestry agents are explained as to technical and economic policies. A chapter is given over to the problems of forestry science, ecological and silvicultural, and herein are listed the existing research institutions and forest experiment stations which carry on continuous studies relating to the many phases of the growth, production, and utilization of the forests of Germany. Courses in forestry as found in German schools are discussed with regard to advantages and disadvantages, and the forest as a practical object lesson is emphasized as necessary to an adequate comprehension of the principles and problems of sustained-yield management.

The final 10 chapters of Dr. Heske's book constitutes an analysis of the basic economic and political conditions of Germany as affecting forest management and production. These chapters contain discussions of recent labor legislation, tenure, forest rights, population adjustment, State restrictions, national forest laws, forest taxation, forest fire insurance, forest credits and the special function of timber industry banks, forest reserve funds and the afforestation program. In these chapters are many passages to arrest the attention of American readers: for example, Dr. Heske presents in no uncertain terms his arguments in favor of diversity in forest ownership, in favor of freedom in scientific research, regarding the rights of users in public forests, and the limits to operating regulations for effective results in private forests.

LAND, BIRDS AND ANIMALS

(Continued from p. 26)

nition which is to be used in accordance with other provisions of the law. This amounts to about \$3,000,000 each year.

The act provides for the allotment of these funds to the State conservation commissions to assist in the development of wildlife restoration projects. These projects must have the approval of the Secretary of Agriculture before Federal aid can be given, and the participating States must contribute 25 percent of the total cost of the work. The act is so drawn as to encourage the development of plans involving research work and particularly the acquisition, reclamation, and improvement of lands by the States. Provided that the appropriations are made as authorized, it is evident that over a period of years this legislation will have very great effectiveness in achieving the objectives of the land-utilization program. It will have application particularly to desirable smaller areas of submarginal and wilderness lands which, because of their limited acreages, are difficult to acquire and too expensive to permit of direct administration by the Biological Survey.

New Publications on Erosion Control and Related Subjects

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by Mrs. ETTA G. ROGERS, Publications Unit

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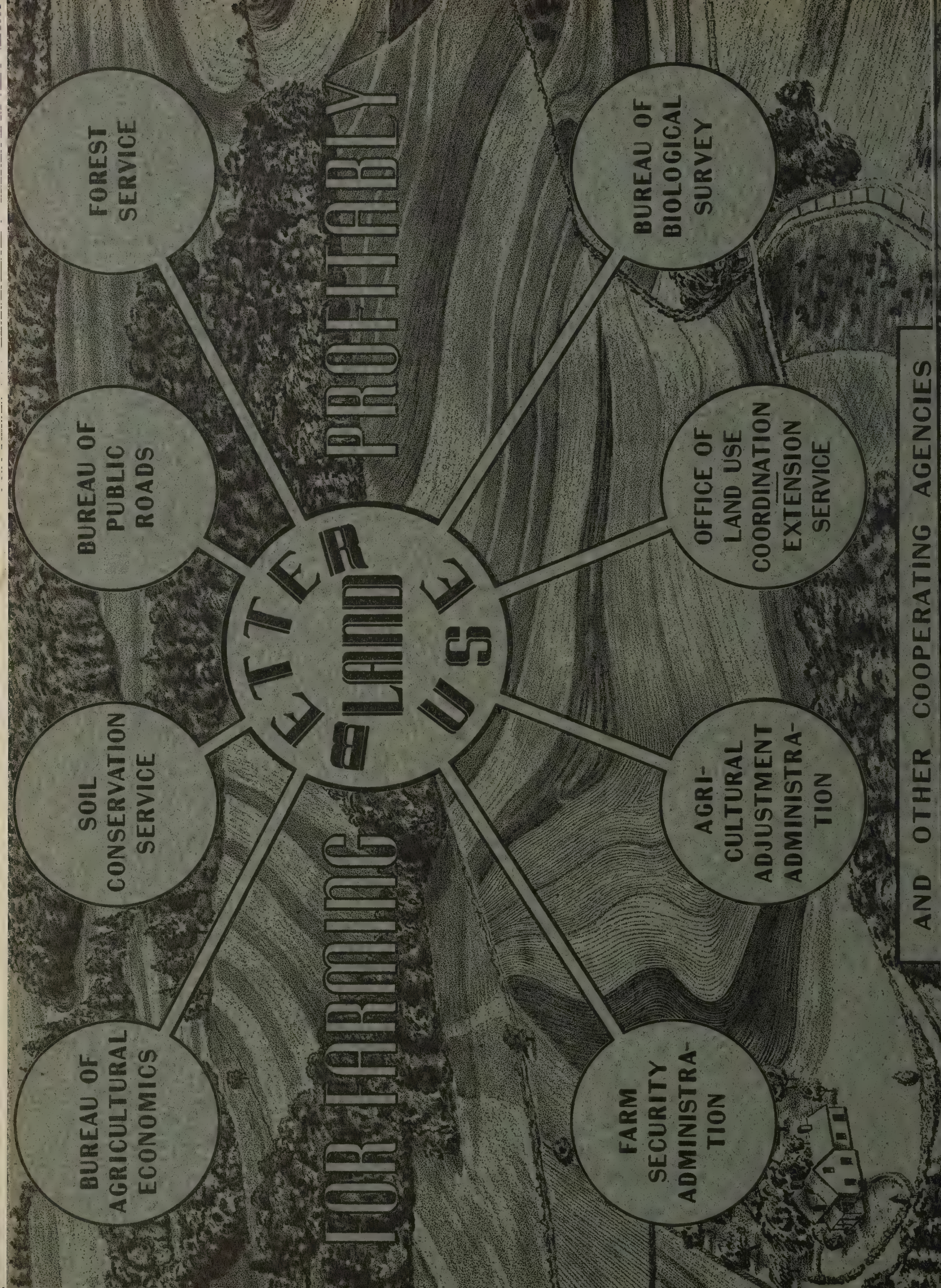
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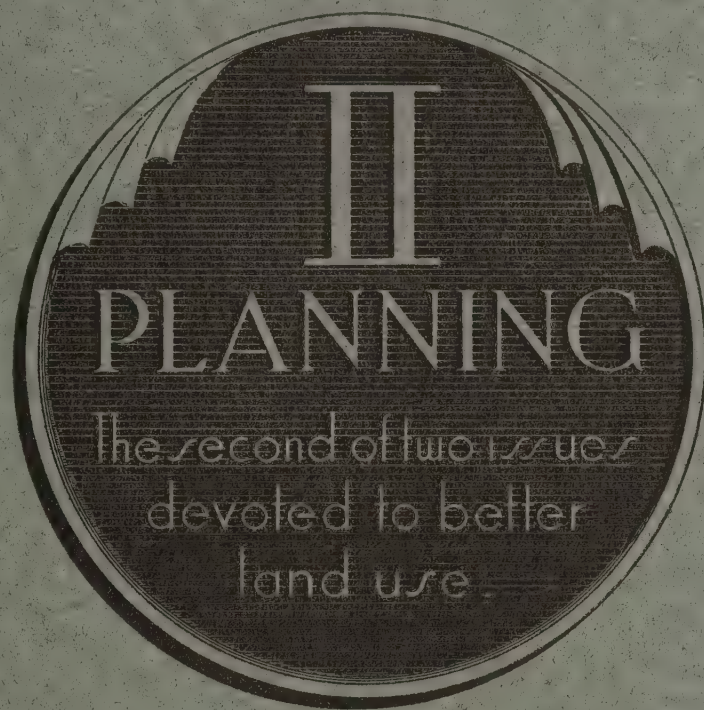
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UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



AUGUST

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WELLINGTON BRINK
EDITOR

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SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

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H. H. BENNETT
Chief, Soil Conservation Service

AUGUST • 1938

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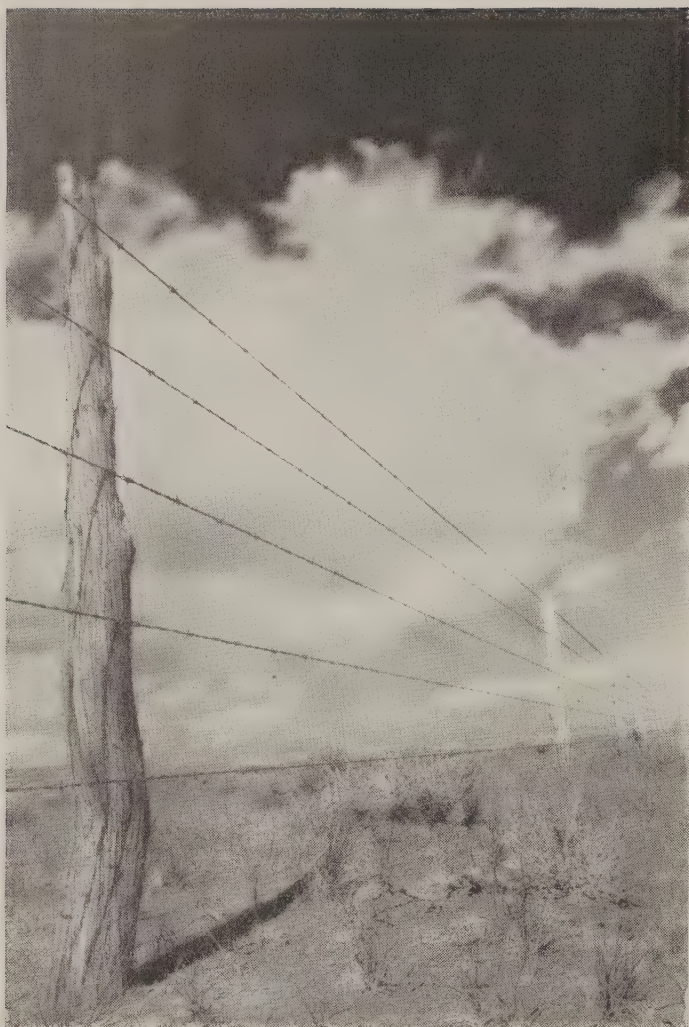
Programs "rise from the soil and from the needs of the people who depend on the soil."

Introductory Statement

THIS is the second of two numbers of SOIL CONSERVATION which deal with the land programs of the Department of Agriculture. The articles in the July number set forth a description of the objectives of programs and of operations on the land. The articles in this number delve more deeply. They tell something of the planning behind the programs. They tell how the programs come into being. While

reading them I found a single theme recurring: The programs of the Department are shown to rise from the soil and from the needs of the people who depend on the soil. Perhaps this theme may be summed up in the phrase "Democracy in land use."

M. S. EISENHOWER,
Coordinator of Land Use Planning.



Fences segregate fields but cannot cut through the overlapping interests of neighbors.

BEFORE 1933 it would have seemed strange had anyone written on the subject of farmer participation in agricultural planning. Who besides the farmer, it might have been asked, should participate in such planning? What agricultural planning is there other than individual farm planning? And even if each individual farmer does not do the best conceivable job of planning his own work, what reason is there for anyone else to participate in his planning operations except to make available to him information that he is free to use as he pleases? Not only would these questions have been asked then, but many people are still asking them.

Particularly during the last 5 years, however, there have been significant developments in public planning of rural land use. These were described in the July issue of *SOIL CONSERVATION* which dealt with planning programs of various agencies of the Department of Agriculture. Such planning is exerting increasingly important influences upon planning by individual farm operators.

It was not only inevitable but appropriate that the emergency programs of these agencies should have been

Farmer Participation

By M. L. Wilson

Under Secretary of Agriculture

planned in large measure by the experts and public officials legally responsible for their administration. But if public programs for agricultural adjustment and land use are to be permanent features of our agricultural economy, as I think they will be, it is important that farmer leaders in the counties, in the States, and in the Nation, play a dominant role not only in determining the broad outlines of such programs, but also in adapting them to the exceedingly complex variations in local conditions.

The most impelling reasons for active farmer participation in public agricultural planning are, first, to ensure practicability in the goals and procedures established and, second, to obtain general acceptance by farmers of the plans developed. These are obvious reasons which almost anyone would promptly suggest—reasons fully supported by recent experience of Department officials with the programs of the Agricultural Adjustment Administration, Soil Conservation Service, Farm Security Administration, and other agencies.

Yet there is a persistent tendency to rely upon expert opinion alone, and to follow the easier method of basing action upon official decisions rather than by the slower process of widespread discussion by, and consultation with, local as well as national farm leaders. This tendency we must guard against with increasing vigilance if we are to avoid a return to the futility of *laissez-faire* or the development of some of the distasteful consequences of bureaucracy.

As a matter of fact, extreme individualism is not one of the alternatives available to us. The real choice is between the democratic and the arbitrary procedures for developing and administering public agricultural programs, and even this choice is one of degree. Our problem is one of keeping at a practical minimum the arbitrary aspects of necessary collective action. In this task there is no substitute for widespread farmer participation in the actual planning of programs, and discussion is the principal technique for such participation. It was in recognition of the need for working out agreement between local, State, and National leaders that county agricultural planning and group discussion has been sponsored by the Department of Agriculture. Some 2,400 counties now have agricul-

tural planning committees, each consisting of 10 to 20 farm men and women who are engaged in determining desirable changes in land use and farm practice.

Since understanding is the first prerequisite for resolving local, State, and National points of view into a workable program, and since there can be no understanding unless the pertinent facts and judgments are available to all groups, it is intended that this planning organization shall serve as a part of the necessary mechanism for transmitting facts and judgments between local and national leaders. No particular organization, of course, automatically ensures agreement as to policies and programs. Agreement almost always must be a compromise in points of view, even if based on the same facts.

This truism has peculiar significance with respect to the relation between the expert and the farmer. Differences between expert and farmer opinion as to needed agricultural adjustments are generally due to differences in available information upon which the opinions are based, but this does not necessarily mean that the farmer has less information. It may mean only that each has different kinds of information, all of which are needed in formulating an adequate program. The expert is often a specialist with vision for only one aspect of a problem. Though the farmer may not see that particular aspect so clearly, he is just as likely to see other pertinent phases of his problem that the specialist overlooks. Beyond this is the fact that policy judgments might differ for reasons no more tangible than differences in social philosophy.

Thus I conclude that no group of people is more suited to synthesize the judgments of specialists and to forge them into workable programs than responsible farm leaders who know farming as only experienced farmers can know it. This is only another way of describing the democratic principle which requires experts and specialists to function as advisers to representative laymen. Democracy is not government by experts. The best democracy is government with the aid of experts. It is upon this philosophy that the present Department of Agriculture is attempting to build agricultural planning. Because of this philosophy, the Department holds that a program which moves in the right direction, though not quite representing perfection in the eyes of the expert, is preferable to no program at all. This approach is pragmatic and is based on the conviction that planning in a vacuum will be no more effective in improving farm life than "equilibrium economists" have been helpful in social reform. Its premise is that economics is a social process; not an "equilibrium of forces."

To avoid "planning in a vacuum," and thereby to sustain farmer interest in participation in planning, the Department now proposes that in each State and in each county the official representatives of each State and Federal agency having responsibility for land-use programs, meet with the farmer planning committees in an effort to relate planning to administration. It is not reasonable to suppose that farmers will continue to render volunteer service in public planning if there is no evidence that their efforts are being translated into action. Nor will they function effectively if Federal and State officials attempt to dominate or to operate other than as consultants and advisers.

Here, therefore, are twin problems of real magnitude. I know of no institution or group of institutions as well equipped, both with experience and facilities, for dealing with these problems as the land-grant colleges and the universities. The State extension organizations, with county agents in each county, have long since learned that their most effective work is done through farm leaders. The most successful of their agents have learned to get behind farm leaders and advise rather than "tell them." They have accepted as a major responsibility the task of developing farm leadership in its broadest sense. The experiment stations with their research staffs are, by and large, the best qualified agencies to assemble and provide information needed to fill the gaps disclosed by planning work. Merely to list the public facilities which are available for helping farmers participate in public planning is to show that the task is not something entirely unrelated to what has been done in the past. It is, rather, a logical extension and adaptation of existing procedures to meet changing conditions.

Planning by farmers for public programs involves both an ideal and a reality. Progress thus far represents merely a beginning, but only a short period of time has elapsed since the need for it became apparent. The ideal will be approached as the enormous latent forces are marshaled and coordinated for its achievement. It is perfectly clear that American agriculture, which includes the United States Department of Agriculture and the land-grant colleges, is rapidly shifting its internal relationships, in response to world-wide and domestic forces, so as to meet the necessity of public action and at the same time create a form of economic democracy unknown anywhere else in the world. The essence of this shift is American, and it represents progress in our own way. Farmers not only continue to plan their own individual farm operations, but farmer leaders in every community are playing an ever-expanding role in planning public programs.

Over-All Planning—The Next Step



By E. H. Wiecking

Associate Coordinator
of
Land Use Planning

Perspective is needed in the planning of a modern agricultural economy.

ALL intelligent action—public and private—must be planned in advance. Whether the planning process be brief or prolonged, simple or in great detail, directed toward the action of tomorrow or that of 10 years from tomorrow, the essence of planning is forethought—thinking ahead.

Over-all agricultural planning is the fitting together of all public-action programs so that they will reach the watershed, the locality, or the farm as a coordinated and unified attack on local as well as national problems. Such planning involves the effort to see that none of the programs is working at cross purposes, and that all work together efficiently and economically to promote human welfare through a better use of our land, water, and associated resources. Obviously, such planning embraces more than Federal action alone; essential lines of action lie within the province of the States, and still other vital types of action depend upon local initiative. Among other things, therefore, the task involves close cooperation between the Department of Agriculture and the land-grant colleges—the primary public agencies best equipped for agricultural research, planning, and education.

The most useful type of planning requires the consideration of many factors, some of which are outlined and discussed in this article. In the first place, all of us must clearly recognize that out on the watershed and on the farm, where our real job lies, we are dealing with a complex of interrelated factors—dealing not with one problem but with a bundle of problems.

Action to correct one phase of a land-use problem may be nullified by lack of adjustment in other factors that impinge heavily upon it. Or, single-line action, with respect to one factor, may throw other factors in the problem out of line.

The task of controlling erosion, for example, cannot be confined to the construction of terraces, or to the restoration of more land to grass or other vegetative cover. In many situations, the agronomic requirements for erosion control would seriously curtail farm income, and possibly the tax income of the local units of government, unless a change were made either in the type of farming or in the size of farm operating units, or both. In a significant recent study by the Iowa Agricultural Experiment Station, soil erosion and the extent of tenancy were shown to be highly correlated. That study brought forth another important element in the erosion-control problem—credit. The extent and degree of erosion varied with the debt load per acre. In some States existing State laws and policies on assessment and taxation stand in the way of the type of land use necessary for soil conservation.

Again, in parts of many “problem areas” one will find that application of the accepted methods of erosion control is either technically impracticable or financially prohibitive, so that for those parts the conclusion might well be retirement from cultivation. Obviously, this raises the question of the people involved, and immediately one is faced with some very real problems of human adjustment. Possibly through relocation

of the present occupants, and dedication of the submarginal land to public forestry, an economy can be built up which will combine farming with forest income. Furthermore, investigation may show that in this submarginal land area, the roads, schools, and other public services are maintained only because of heavy grants-in-aid by the county or State, or from other sources—this in view of the fact that the low productivity of the area makes impossible tax payments sufficient for even reasonable self-support. And that suggests that discouragement or prevention of further settlement in such areas—through rural zoning, for example—needs to be considered, not only to prevent the opening up of new areas to erosion and deposition of the soil on good lands farther down the watersheds, but also to prevent the imposition of still heavier taxes upon the owners of good lands to be supplemented by more grants-in-aid.

Nor can one escape the influences of factors whose mainsprings may lie far outside the problem area—such things, for example, as shifts and trends in market demand, in product prices, in technology, in those frequently unapparent but nevertheless powerful underlying forces that collectively go to make up interregional competition.

Thus, regardless of the factor with which you start, you are soon confronted with a bundle of interrelated problems. Effective action can begin only when everyone recognizes that he is dealing with a complex of interrelated variables. How important this interrelation of factors is, can, of course, only be evaluated by analysis—which leads to a second suggestion.

This second suggestion has to do with the need for an over-all, inclusive land-use planning procedure for our rural problem areas, based upon the concept that we are dealing with a complex of interrelated factors. The development procedure may be described as having three steps:

Step 1 involves area analysis and classification. This, it is suggested, has two phases. First, area analysis, in which by field surveys and other careful studies of a problem area, we get the picture of the complex, the important factors in it and how they are related. This is essentially a task of marshaling the facts, on maps where possible, as a basis for determining policies. The second phase is area classification. In reality this is an economic land-use classification, which, also in map form, shows what the “best” long-time uses of the various classes of land in the area are judged to be, and which is further subclassified in terms of the factors that require adjustment for the achievement of those “best” uses. Perhaps, however,

the process of classification should be regarded as having two phases within itself: Classification in terms of “best” use (or use combinations) defined as “ideal”; followed by classification in terms of “best” use or uses defined as the “best practicable,” or the “best attainable,” taking into account the compromises with the “ideal” that the realities of the situation may impose, at least in the foreseeable future. The importance of classification is that different combinations of factors may require different lines of action.

Step 2 is concerned with policy analysis and the selection of alternative lines of action. Though it is true that realistic area classification cannot be made wholly apart from any consideration of methods for accomplishing the ends agreed upon, it is generally true also that a given end may be achieved by alternative means and methods. These methods include, for example, changes in the tenure system, in local government and public finance, in credit policies and practices; the establishment of soil conservation districts, cooperative grazing associations, rural zoning, differential taxation; and so on. We ought to consider the whole range of possibilities that promise to be helpful. That range of possibilities—let’s call them tools in our kit of social instruments—runs all the way from education with reliance upon individual action, to public ownership and control.

We also need to ask ourselves such questions as these: Which is the best single instrument for the accomplishment of our land-use objectives? Does this main instrument need other lines of action to supplement and support it? Or is there no one instrument upon which main reliance can be placed to get the job done; and, therefore, do we need to use a combination of several instruments? In certain situations we may, for example, need the soil-conservation district, plus zoning, plus public purchase. We frequently have a tendency to think that some one line of action provides all the answers, when, because we are dealing with a complex of interrelated variables, the attainment of our objectives requires a combination of several tools, each of which has its advantages and its limitations.

Step 3 consists of program making. Having considered steps 1 and 2, we can now more intelligently develop a unified program of action. Nothing will do more to bring about coordination among action programs—administrative coordination, if one wishes to use that term—than procedure upon these three steps as a basis. If we do this all of us can see more clearly where we fit into the total job to be done, and coordination will be well on the way. And over-all land-use planning, conceived and carried out in a common-sense

manner, should not place interferences in the way of the action programs, which obviously must move forward without undue delay. Far from impeding programs, over-all agricultural planning should actually expedite them.

This brings us to the third important feature of our study—we must organize to facilitate coordination. This may mean new ventures, new experiments, in methods and mechanisms of agricultural coordination.

On the ground, in the watershed, in the county—here is the real foundation for coordinated rural land-use planning and action programs. In my judgment, coordination at the State, regional, and national levels must be built upon over-all agricultural planning on a local area basis. At this foundation level we must first recognize that the job will never be done right unless the available technical manpower is organized to operate as a body under a planning leader who can at all times see the problem as a whole, who can keep in mind the goal of a practical, workable plan, and can coordinate, weigh, and balance the activities of the contributing specialists toward that end. To be efficient and effective, the technicians' contribution to planning, like action itself, requires leadership, decision, and administration.

On the ground, in the watershed and in the county, we must make the county agricultural planning committees senior partners in the process. In a democracy public programs of action must be understood, approved, and supported by the people directly affected thereby, and for whose primary benefit these programs are established. Out of long practical experience on the land comes a knowledge and a judgment which is an indispensable part of that collective human wisdom which constitutes the essence of sound planning and constructive action. Necessary local and State action never will be initiated unless the citizen understands thoroughly and concretely his need and the importance of the action to himself and his neighbors. Farmer planning committees—more than 2,400 of them—are now at work in practically every agricultural county in the country. Their record to date is most gratifying.

And now we come to the State level. As is well known by all members of Department and land-grant college personnel, steps are now being taken to establish State agricultural advisory councils. Under the proposed chairmanship of the respective State directors of agricultural extension, these councils will bring into a continuing, cooperative, over-all agricultural planning activity, the leading agricultural agencies of the State, recognized farmer leaders from the different type of

farming areas in the State, the State officials of the Department of Agriculture's action programs. Space will not permit further discussion of this development here, but all readers of SOIL CONSERVATION will recognize its significance for achieving coordinated action through coordinated, over-all agricultural planning.

At the regional level many agricultural problems require special regional and interstate consideration. This is analogous to effective action on many of the land-use problems in our bundle of interrelated variables which cut across county or watershed lines and require State consideration. To facilitate over-all regional agricultural planning, the Department of Agriculture in 1936 appointed a coordinator for the southern Great Plains, and a few months ago, a coordinator for the northern Great Plains. The Department and the land-grant colleges in these two areas have established cooperatively two regional agricultural councils composed of the coordinators, the regional directors of the Department's action programs, Washington Department officials of operating programs not having regional offices, the State directors of agricultural extension, and others in the agricultural field. The State extension directors in turn serve as chairmen of the respective State agricultural councils. These comparatively recent developments at the regional level have proved of very great value in securing an effective coordinated Federal, State, and local attack on the serious agricultural problems of this large and troubled region.

At the national level we find that the appointment by the Secretary, somewhat less than a year ago, of a Coordinator of Land-Use Planning, and establishment of the Office of Land-Use Coordination, constituted a significant organizational development within the Department itself. The set-up, functions, and responsibilities of this office for achieving coordinated agricultural planning and action within the Department, between the Department and other Federal agencies, and between the Department and the appropriate State agencies in the land-use field, are already too well known to require further discussion here.

New needs must be met by new means and mechanisms. The emerging organizational structure for coordinated rural land-use planning, as outlined above, brings into cooperative activity those citizens and official agencies best equipped by reason of facilities, training and experience to assume primary responsibility for the No. 1 job of over-all agricultural planning-for action now before us. Their combined judgment is entitled to acceptance as valid and authoritative for

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One device to save water for a season's crops and to hold soil for present and future generations. This South Carolina farm illustrates one small piece of the new agricultural pattern.

That Soils and Waters May Remain Permanent Assets

By Dillon S. Myer, Assistant Chief, Soil Conservation Service

NATIONAL land-use planning in a broad sense defines prevailing land-use problems, points the way to necessary social, economic, and physical adjustments, and projects a coordinate course of action for the various agencies working toward the common objective of better land use.

The primary objectives of the Soil Conservation Service are to control soil erosion and conserve water. Since soil and water conditions are important factors in determining the use to which land properly may be adapted, plans and programs for soil and water conservation are essential elements in designing the broad pattern of national land use.

The planning of the Service, however, involves more than the development of physical measures for the protection of soil and water; also necessary are readjustments of those social and economic forces that tend to encourage the destructive use of natural resources. Accordingly, plans to control soil erosion and conserve water must be correlated with the plans of other agencies seeking similar adjustments whether physical, economic, or social in nature. Obviously, where certain social, economic, or physical adjustments are desirable in forwarding the objectives of two or more agencies, and consequently the national land-use program, joint planning by the agencies concerned leads to more effective action.

In developing the national soil and water conservation program, the Soil Conservation Service has brought the planning function into immediate contact with problems of the land. Demonstration areas have been established in distinct agricultural regions, so that erosion and water problems common over considerable areas may be solved for the benefit of those in need of this type of assistance. Broad erosion problem areas have been outlined. For most of these problem areas, the Service has provided one or more demonstrations. C. C. C. camps under the technical supervision of the Service were located on the same basis, and in the placing of camps, the type of work involved in the expected program was carefully considered so that enrollees' time can be most effectively used. Also considered in the selection of demonstration areas is the presence, or absence, of local interest. The Extension Service has cooperated throughout in determining the extent of this interest. Local farm leaders, business men, and representatives of various local organizations are consulted. Little has been left undone to determine in advance of establishment whether or not local interest warranted cooperative demonstration project work.

Immediately after an area is selected for demonstration purposes, a project work plan is developed. In this planning, all available physical and economic data are studied. The extent of different types of erosion in relation to slopes, soil types, and land use is determined by means of conservation surveys. Data on the land-use distribution to crops, pasture, range, and woods, are obtained. The extent of idle and waste land is noted. Historical and social information is sought to determine as nearly as possible the past use of all parts of the area, the growth of population, location of social and economic centers, present and past market outlets, roads and educational facilities, and similar data that will reflect possible reasons for existing land conditions, agricultural balance, and community pattern.

Often, in developing the project plan, individual farms are analyzed to determine what vegetative covers and cultural practices have furthered conservation, or allowed erosion. Cropping and fertilization practices are studied. Factual data concerning the kinds, types, and numbers of livestock, as well as the market distribution of livestock and their products, are considered. In this field, the dominant feeding and grazing practices are important. And once each distinct factor is considered in the light of other related factors, and all the information synthesized, a basis is obtained for the development of sound and coordinated project plans.

Normally, in the development of plans for project areas, certain questions reappear regularly and require individual answers according to conditions existing in the specific area. For example, the extent of land-use changes necessary in the light of erosion, slope, and soil-type information, must be determined. The changes in farming practices necessary to safeguard the desired land use must be ascertained. Machinery, equipment, buildings, and labor invariably receive particular attention. Changes in the numbers or management of livestock always warrant careful consideration. Possible market outlets for any new products must be analyzed, and if farmers do not have technical knowledge of desirable new crops or practices, some latitude in time must be allowed them that they may become properly informed and gradually adapt these changes to their already established systems of farming. The question is, How much time?

Reduced to simplest terms, the basis for project work is proper planning for each unit of land. Individual farmers assist in the development of plans for their respective farms. With the Service, they enter into 5-year cooperative agreements which outline the entire farm plan and specifically set forth the obligations of both the farmer and the Government. The farmer agrees to follow the practices stipulated in the cooperative agreement and provide as much of the labor and materials as possible. In return, the Government agrees to provide whatever technical assistance is needed as well as additional labor and materials necessary to put the plan into effect.

Proper land use is the goal for each acre of farm, and accordingly, individual farm plans, like project plans, are based on an inventory of physical and economic conditions. Included is an analysis of the demands made by the individual farmer and society on the land. Consideration is given to the location of the farm, present and possible market outlets for commodities and livestock, and other related factors. Also important in the development of a farm plan is the historical information concerning past treatment of the land, since past treatment usually accounts in some considerable degree for its present condition.

Obviously, a plan for erosion control and water conservation includes far more than blanket recommendations for individual types of treatment. There is a definite relationship between each element of the plan, and together, all the elements exert a strong influence on the farm, on the community, and eventually, on the Nation.

The demonstration work of the Soil Conservation Service has played, and is expected to play for a number of years to come, a fundamental part in the develop-

ment of a national soil conservation program. It is recognized, however, that the demonstrations are no more than a first step toward a more comprehensive program. From the standpoint of national adequacy, effective soil and water conservation requires the coordinated treatment of all lands in every part of the country and the applied cooperation of many farmers, State institutions, and Federal agencies.

The soil-conservation district provides an avenue toward this broad objective. It is a legally constituted subdivision of the State, possessed of unusual possibilities for furthering better land utilization through cooperative, community action. The responsibility for the establishment and management of the district is vested in persons within the district itself, and within the State. The district supervisors, representing their neighbors within the district area, may call on any and all agencies for assistance. Moreover, the supervisors are assisted in their requests for help by their State soil conservation committee, which may also aid the district in other ways.

The program of a soil-conservation district, to be most effective and beneficial over a long period of time, should be developed in much the same manner as that of the Service demonstration project—in the light of all physical, economic, and social conditions within its area. In addition, the program should be tempered according to the relationship of the district to large neighboring regions and to national conditions. Several governmental agencies can provide helpful information and assistance in guiding this work. For example, the Bureau of Agricultural Economics has been carrying on studies of land utilization and has participated in the determination of problem areas. This type of information is helpful not only within a single district but in providing the basic framework, or guiding pattern, for larger areas to which the programs developed for several districts would conform. In many States, county planning-committee work is progressing under the auspices of the State extension service, with Department of Agriculture agencies cooperating. Recommendations relating to revisions and changes in county land use, cropping patterns, conservation practices, local government systems, and other county features have been made. Where this type of information is available, it will be valuable in the development of district programs and work plans.

Many other examples may be given to indicate ways in which governmental agencies such as the Soil Conservation Service, Forest Service, Biological Survey, Bureau of Agricultural Economics, Farm Security Administration, Bureau of Public Roads, Farm Credit

Administration, Agricultural Adjustment Administration, Extension Service, the Agricultural Experiment Stations, and others may provide real help in the planning and development of soil-conservation districts.

Soil-conservation districts are now being established rapidly in several of the States having appropriate legislation. In most cases farmers are apparently enthusiastic about the opportunity to organize for community action and joint benefits. At the same time it is recognized that, for best results in the district undertakings, farmers should have mutual and interrelated interests. Political subdivision boundaries, such as county or township lines, have little significance in the determination of areas for soil-conservation work. More important are the topographic, climatic, land-use, drainage, and erosion characteristics. For purposes of planning, and for the general effectiveness and continuity of work, it is desirable that problems and characteristics of a district be analogous. In different words, widely varying problems and characteristics would tend to impede the rapport essential to successful operation of a district program.

The soil-conservation district, of course, is not a creation of the Soil Conservation Service; nor does the district come within the administrative purview of the Service. Created by farmers under State law, its operation is essentially local. The act of Congress, establishing the Soil Conservation Service, however, makes the control of soil erosion a national policy, and the Service an instrument in effectuating that policy. It readily follows, therefore, that the Soil Conservation Service is interested not only in the erosion-control work initiated and carried on under its direct supervision, but in all activities leading to soil and water conservation in the United States, whether conducted by individuals, private organizations, or governmental agencies or subdivisions.

Accordingly, the Service is vitally interested in furthering the proper establishment and operation of soil-conservation districts. And because they promise widespread progress in soil conservation, districts necessarily assume important proportions in Service planning. Currently, these plans anticipate a steady increase in the number of districts, and subsequently, a steady increase in the number of district requests for various types of assistance. In the discharge of its public responsibility, it is the policy of the Service to provide such aid insofar as practicable and possible.

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PLANNING THE A. A. A. PROGRAM

By F. F. Elliott¹

THE PLANNING of an action program such as that administered by the Agricultural Adjustment Administration, whereby practically every farmer in the United States is either directly or indirectly affected, obviously is an important as well as a complicated task. It is a task which has involved, and will continue to involve, the cooperation and assistance of a large number of people. It is not an undertaking which farmers working alone can carry through; nor can the job be done by technicians working without the aid of the farmers. For most effective results the participation of all interested parties is essential—the farmers, the soil technicians, and economists as well as the administrative staff. Planning the Agricultural Adjustment Administration program therefore is not a routine, stereotyped, blueprinted, or engineering type of procedure. It is, rather, a continuing process of modification and adaptation, either through new legislation and amendments to existing legislation, or through changes in administrative rules and regulations, changes in rates of payment, in total soil-depleting or special-crop goals.

The initial step in program development takes place, of course, in the formulation and passage by Congress of legislation under which programs are authorized. The important influence which this step has in program planning is often overlooked. But legislation under which programs are operated obviously determines the general framework within which they must be developed and sets forth the general principles upon which they are founded.

In the development of such legislation, Congress necessarily endeavors to consider all sides of the ques-

tion and attempts to coordinate and compromise the conflicting interests involved. The legislation itself either must be so drawn as to permit the administrators considerable freedom of action and discretionary authority, or must be amended from time to time in order to meet changing conditions or to provide for improvements indicated by actual operation of the program. Numerous examples could be cited of the important influence which "legislative planning" of the character mentioned has had upon the Triple A program during the past 5 years.

The second step in planning the Triple A program involves the setting up of over-all total soil-depleting, soil-conserving, or special-crop goals in the interest of furthering the objectives of the act and the development of administrative rules and regulations and the calculation of rates of payment. This step calls for analysis of the current situation and for interpretation and use of the flexible powers provided in the legislation, so that the program best will meet the needs of farmers during the time in which it is to be in operation.

The third step in the planning or development of the program involves the breaking down of the over-all goals, rates of payment, etc., by States, counties, and individual farms and the selection of soil-conserving crops and practices to be encouraged and instituted in the different regions, areas, and on individual farms. This is a function largely performed by State, county, and community committeemen, who administer the program in the various States, counties, and communities throughout the Nation. These men are themselves farmers, and are necessarily in direct contact with the farmers to whom the program applies and are thoroughly familiar with the problems which

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With price and credit arrangements outside the control of even well-managed farms such as this, Congress in the last few years has provided assistance toward group action and the conservation of the soil.

the rules and regulations raise and with the modifications that are needed.

Under the program as usually developed, the community and county committeemen are given considerable discretion with respect to the adjustment and establishment of individual goals, and some discretion with respect to the interpretation of certain rules and regulations, so that the program may be best adjusted to fit the needs of the county or community in question. In addition, where rules and regulations as originally formulated do not fit local conditions and where modifications are obviously needed, the questions which are raised by the local committeemen and transmitted to the Administration through State committees usually result in modification of the program so as to ease the particular situation and to encourage participation in the program.

The work of the economists, soil technicians, and administrative staff in formulating the rules and regulations for a program under existing legislation is an annual task, and it is a process which is often referred to as planning or as program development. In carrying out this step or in developing the outline of a program under the Soil Conservation and Domestic Allotment Act and the recently enacted Agricultural Adjustment Act of 1938, it is necessary that attention be directed toward three sets of factors or influences in order that maximum results may be obtained.

The first factor to be considered in developing an agricultural conservation program is, of course, the need for soil conservation. In this field the Administration is guided by the research work, experience, and advice of the several State experiment stations and the Soil Conservation Service and the suggestions of farmers themselves with respect to shifts in the acreage of depleting crops and with respect to soil-building or soil-conserving practices which are needed in each area or region.

In general, it may be said that the systems of farming which are most desirable from this standpoint are those in which the acreage of soil-depleting crops is minimized and the acreage of soil-conserving crops is maximized. In addition, there is a large acreage in the United States on which certain practices must be carried out if the soil is to be effectively conserved. This is especially true in the Great Plains region where special practices are needed in order to prevent wind erosion, and on almost all the sloping or rolling farm lands of the United States where cropping systems and specific practices should be instituted in order to prevent gullying and sheet erosion.

But farmers find it difficult, if not impossible, to conserve their soil unless they receive an income adequate to support their families and to pay their taxes, operating expense, and interest. As a result, the second factor which must be considered by the technicians and administrators in developing a program is the income factor. Consideration must be given, therefore, to the current supply and price situation with respect to each crop or group of crops, and especially with respect to the major soil-depleting crops—cotton, corn, wheat, and tobacco. An effort must be made also to arrive at a best judgment as to the acreage of each crop or group of crops which is required during the current year in order most effectively to balance supplies of the particular commodity with demand.

For the present, the acreage available for the soil-depleting crops is sufficiently large to produce a supply that is more than adequate from the standpoint of the market, so that a downward adjustment is needed. As a result, the adjustment needed from the standpoint of income tends to coincide with the adjustments needed from the standpoint of soil conservation. Not only does a downward adjustment in the acreage of soil-depleting crops tend to bring about a better adjustment between supplies and demand, but it also leaves a larger acreage available for soil-conserving and erosion-resistant crops. It, likewise, allows the farmer to remove his least productive acreage from intensive cultivation, thus lowering his unit costs of production. This, furthermore, results, or should result, in the maintenance or increase of soil fertility, thereby serving as an effectual guarantee of adequate supplies at such time in the future as they may be needed.

The third factor which must be considered in working out acreage goals or developing a program is the requirement of supplies and acreages from the standpoint of domestic consumption and foreign demand. Although the Soil Conservation and Domestic Allotment Act and the Agricultural Adjustment Act of 1938 both have the increase of farm income as a major objective, it is also recognized that consumers' interests must be protected and that agricultural prices must not be raised to so high a level as to curtail supplies for domestic consumption. The acreage goals which are established under these acts must be sufficiently large, therefore, to allow for a per-capita consumption of the several fibers and foodstuffs equivalent to that which prevailed during the relatively prosperous period from 1920 through 1929, adjusted for trend where per-capita consumption shows a steady increase

or decrease over a reasonable period. In addition, consideration must be given to prospective export demand. It is desirable that exports of American agricultural products be maintained at as high a level as possible, provided that a reasonable price is obtained.

This consideration of the need of consumers and the export market may seem to work to the disadvantage of farmers in any particular year in that higher prices or an increased gross income for the particular year could perhaps be obtained by cutting supplies under the level needed by this standard. But in the long run it is to the interest of the farmers as well as of consumers that adequate supplies be maintained for domestic consumption, since it means a more stable market, since it indicates that farmers and consumers recognize each other's problems and are willing to cooperate in a remedial program, and since it means that the development of substitutes and shifts in consumption will be minimized.

The technicians who work on program development, then, must consider the need for soil conservation, the current and prospective supply and demand situation, and the acreage needed from the standpoint of supplying domestic consumers and export demand. But it is easy for the technicians to generalize too widely and to overemphasize their viewpoints. It is especially desirable for this reason that farmers, with their intimate knowledge of practical affairs, be directly connected with program development to serve as a counterbalancing influence. After all, it is the elected representatives of the farmers and consumers who enact enabling legislation, and it is the farmers themselves who are most directly affected by, and who are best able to judge as to the effects of, the agricultural conservation program. In addition, it is the farmers themselves who are cognizant of the peculiar conditions which affect each community or county and which tend to be forgotten by technicians or administrators who look at the problems of the Nation as a whole, or, at best, who think in terms of type-of-farming areas or regions in order to simplify and generalize their problem.

Because of this, the Agricultural Adjustment Administration has always insisted, and the current legislation provides that, the agricultural conservation program shall be administered by the farmers themselves in each community, county, and State. In addition, the Administration has endeavored to arrange its planning or program development work so as to allow for the maximum participation of the farmers generally and of the farmer committeemen in the actual work of outlining or developing the program. This has been carried on by an effort to obtain a two-way movement

of knowledge—that is, an interchange of knowledge between the administrators and technicians on the one hand and the farmers on the other, so that the ideas of each group may be presented to the other group for criticism and adjustment.

Specifically, the Administration has cooperated with the Extension Service in carrying forward the county planning project, in which farmers in each county were asked to give their opinion as to the acreages of the several soil-depleting and soil-conserving crops that were needed in the county and as to the adjustments in land use which seemed most desirable from the standpoint of a long-time land-use adjustment program.

Each year when the time comes to build a program for the following year, the farmers have been asked to express themselves with respect to a wide range of questions as to how well the current program fits their particular community or county, as to what changes are needed in acreage goals, in methods of fixing acreage allotments on individual farms, and in practices for which payments are made or credit is allowed under the program. In addition, the farmers themselves have been asked, on a number of occasions in the past, to decide important questions or policies through the use of Nation-wide referendums; and the current Agricultural Adjustment Act specifically provides that the farmers themselves shall decide by the referendum method as to whether marketing quotas shall be adopted with respect to wheat, cotton, corn, tobacco, and rice in years when supplies are burdensome and prices are depressed.

After the general outline of the program is developed and discussed with farmers and farmer committeemen, who are thoroughly familiar with the peculiar situations existing within each State, it is modified in line with their suggestions before it is put in final form and announced.

In conclusion, it should be noted that the simplest conservation program to any individual farmer is, of course, a program which precisely fits the particular conditions which exist with respect to his own farm. On the other hand, a program which is designed to obtain a certain control of acreage, to encourage soil conservation, and to be administered on a large number of individual farms under the same set of rules and regulations must necessarily cut across the interests of particular farmers and must be generalized to a considerable extent. In effect, then, each agricultural conservation program represents a compromise or a coordination of interests that can be built only through obtaining and combining ideas from as many individuals or groups as there are different situations to be

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SECURITY FOR THE TENANT FARMER

By Edwin R. Henson¹



Part way up the hill, the farmer pauses to consider "What lies ahead for myself and my sons?"

OUT of the task of administering relief to over 1,000,000 farm families, there is gradually being developed a technique in agricultural planning which may go far toward effecting many long-needed adjustments in agriculture and preventing recurrence of such widespread rural distress.

While many needy farm families were the victims of droughts or floods, the great majority were in distress either because they were farming unproductive lands or because they were following methods which could be successfully continued only with a relatively high agricultural price level. Many of these families had been farming efficiently and industriously; yet when the returns in agriculture fell far below normal, they found their resources entirely inadequate to support their families or even to allow them to continue in the farming business.

During this period many farm owners were unable to meet their financial obligations and, as a consequence, they lost their farms. The drastic reduction in farm income compelled many absentee owners to return to their farms, thus adding the tenants they displaced to the distressed group in agricultural areas. As a result, many families who were unable to obtain land, those operating farms with inadequate equipment, and those farming submarginal lands were eventually forced to seek assistance.

Direct relief was at first given to families in need, although it was soon discovered that many farm families did not desire this type of aid. They wanted

credit to finance their farming operations. Loans then were extended to farm families who were living on farms, while relief was continued for those unable to obtain land. Many farm families suffered severe hardships before they would accept relief. Many others secured loans to operate uneconomic farms, so that the extension of credit was merely another way of extending relief.

The opportunity for these agricultural workers to move to new agricultural areas, or into cities for industrial employment, was no longer available. What trend there was in this direction was more than offset by the fact that great groups of industrial unemployed were turning to farming, where theoretically they could at least "raise something to eat." Families moved into abandoned houses on any farm lands available. Squatters were in evidence everywhere, eking out a character-destroying existence, for the most part through charity and what little work they could find.

Various Federal and State agencies were created, or old-established agencies were asked to take on new functions, in an attempt to alleviate and eventually correct the distressed condition of agriculture. Agencies were established to effect an adjustment which would give a better return to agriculture. The appalling inroads of erosion on the productivity of much of our farm land became evident when agricultural prices fell. The Soil Conservation Service was established to assist in checking further loss. The fact that many farm families were trying to farm land

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so poor or so dry, or so poorly adapted to the use to which it was put, gave impetus to the land-use planning work and to the program to enable relief families to move from submarginal areas to land on which they could reasonably expect to make a living.

The extension of direct relief to needy farm families did not assist them in becoming independent, self-supporting farmers. On the contrary, this type of relief enabled many farm families to remain in submarginal areas which could not be successfully operated even with normal agricultural prices. Such families would continue to be relief clients as long as they remained on these farms.

Progress toward the rehabilitation of these farm families began with the adoption of the policy of making loans only where sound farm and home plans could be prepared, indicating an ability to repay the loan in 5 years and, at the same time, provide a living for the family. This policy placed those farmers who were on good farms on a program which, at the end of 5 years, would leave the farmer with equipment and frequently with sufficient operating capital to continue farming without any outside help. Families on farms for which sound farm plans could not be made were urged to leave, and were given outright relief until a satisfactory farm or other occupation could be found for them.

At the present time the Farm Security Administration has the responsibility of administering the funds for the rehabilitation of these low-income farm families. It is contemplated that funds available under the Bankhead-Jones Farm Tenant Act will be used to assist some of the most competent rehabilitation clients to establish themselves as farm owners. In addition to these rehabilitation clients, the Bankhead-Jones Farm Tenant Act will enable other tenants, laborers, and sharecroppers, who have never been on relief, to become farm owners.

County and home supervisors have been appointed in all counties where there are large numbers of farm families in distress. The chief function of these county supervisors is to study the needs of these families, to assist in planning their agricultural operations, and to extend such financing as is necessary to enable them to get back on their feet and become self-supporting.

In each county a Farm Security Advisory Committee, consisting of three leading farmers residing in the area, has been established to advise the county supervisor on the rehabilitation of individual farm families and the farming programs best suited to their land.

Within each State there has also been appointed by the Secretary of Agriculture a Farm Security Advisory Committee of nine men, usually including the Director of Extension Service, the Director of Vocational Agriculture, a representative of the Planning Board, and other leading agriculturalists. This committee reviews all phases of the program and suggests areas within a State where tenant purchase loans may best be made in accordance with good land use. This advisory committee goes still further in assisting the Farm Security Administration in outlining policies under which these loans will be extended, and in recommending the size and type of farm believed to be most desirable.

In areas where soil erosion is a problem, the farm plans are being checked by Soil Conservation Service experts, wherever possible, in order that the borrower may have the benefit of a sound erosion-control program from the start. The plans also are drawn to comply fully with the Agricultural Adjustment Administration program. Specialists from the agricultural colleges have agreed to assist in the planning, and in many States they are working very closely with the Farm Security advisers.

The families being assisted by this program are expected to produce as much of their living as practicable from the farm. They follow a farm and home budget which provides ample funds for a satisfactory standard of living, plus sufficient income to repay the obligation to the Government. The security of these families is further assured by the substitution of a variable payment program for the customary straight amortization payment. This variable payment system adjusts the sum due each year to the crop yield and agricultural prices in such a way that relatively small collections will be made in years of partial crop failure, while heavier payments will be required in years of good crops and high prices.

The Farm Security Administration is cooperating in an experimental way with other agencies in Coffee County, Ala., and in Union County, Iowa, in an effort to arrive at a more satisfactory method of coordinating the services of all agencies concerned with adjustments in agriculture and farm planning.

In Coffee County a planning council, consisting of representatives of the various State and Federal agencies, has been established to serve as a clearing house for the various programs in the area. The following agencies are cooperating in this service: State Agricultural College and the Extension Service, Vocational Agriculture and Home Economics, Soil Conservation Service, Land Use Planning, Forest Service, State De-

partment of Education, State Board of Health, Farm Credit Administration, Agricultural Adjustment Administration, and the Farm Security Administration.

Certain areas in Coffee County should be converted from cash cropping into forest. This would make desirable the abandonment of certain roads and schools and a considerable expansion of livestock production. As a basis for the many adjustments required, the Land Utilization Division has made a study of the entire county, indicating which areas require a change in land use in order to assure a sound, long-time farming program. The Soil Conservation Service and the State college have prepared soil maps and surveys for the area. The Farm Security Administration and the State college have cooperated in the preparation of farm programs for the various communities in the county and for the various soil types in each community, effecting the adjustments shown to be desirable by the soil-conservation and land-use surveys.

Farm Security Administration loans are extended to farmers in only those areas where the agricultural program is in accordance with the recommendations of the planning council. Similarly, loans will be extended to enable farmers to move from the submarginal areas and to establish themselves on better land. Many of the individual farm plans contemplate the reforestation or seeding to grass of large areas which are badly eroded.

In Union County, Iowa, the Agricultural Experiment Station, the Extension Service, and the Farm Security Administration have entered into a cooperative agreement, under which all these agencies will put their best efforts into planning for the 90 farms on which farmers are being rehabilitated in the county. The adjustments made will be in accordance with good land use and the Soil Conservation Service program, in order that the productivity of the soil may be maintained or increased. The specialists of the college, the Extension Service, and the Farm Security Administration will help these families in keeping adequate farm records. These records will be analyzed by specialists at the college, and further modifications of the program of each individual farmer will be made whenever this analysis indicates such changes to be desirable.

The extension of credit through loans, based on carefully prepared farm and home plans, is proving most helpful in bringing about desirable adjustments in agriculture. In many areas, adjustments which have been advocated for years by representatives of the agricultural colleges, with but little practical response, are now being carried out. Usually such far-reaching changes require an outlay of cash and equip-

ment beyond the means of the average farmer. Only when a farmer can secure funds, under favorable terms, for the purchase of necessary equipment and livestock, can he make the necessary adjustments in his farming operations.

In the purchase of farms under the Bankhead-Jones program, every effort is made to arrive at a price which is in accord with the land's productive capacity. The long-time earning capacity of the farm is used in arriving at its value. Only those farms are being purchased on which the normal return, as rent, to an owner or landlord is sufficient to pay taxes and insurance, maintain the property, and repay a loan for the purchase of the farm in 40 years at 3-percent interest.

This method of purchasing will have a stabilizing effect on land values, since long-time average yields and prices are used in calculating the agricultural value of the farm. There are areas in which land values are temporarily inflated and farmers are willing to pay more than the land will actually earn. As long as this is true, the Farm Security Administration will not be in a position to buy farms in these areas. The Farm Credit Administration and various insurance companies are likewise extending farm credit on the basis of agricultural or production value. Close cooperation among agencies extending farm credit on this basis should have a marked effect in stabilizing land values.

The goal of this program is to establish families on farms acquired at a fair price, of such a size and farmed in such a manner that the purchaser will have security of tenure and an adequate family living, and still be in a position to repay his obligation to the Government.

Farmers established on these security farms are expected to operate them with a little different philosophy, in that security of tenure, a comfortable home, adequate living, and a desirable environment are sought rather than a large cash income. Such a farming system does not mean turning back agricultural progress and resorting to hand labor. Even though these families are expected to produce as much as possible of their living from the farm, the method of financing permits them to take advantage of improved machinery and modern farm practices.

At least 5,000 farm families are expected to purchase farms with the help of the Farm Security Administration next year. Approximately 400,000 farm families will be operating their rented farms under farm and home plans and rehabilitation loans. Many of this latter group will become free of indebtedness during the year, and ready to undertake the purchase of a farm of their own.

Planning for the Land Utilization Program

By M. M. Kelso¹



THE problem of submarginal lands, toward which the land-utilization program of the Bureau of Agricultural Economics is directed, is a complex of many different factors demanding the application of many different methods of solution. Purchase and development of submarginal lands, as Dr. Gray pointed out in the July issue of *SOIL CONSERVATION*, is the leading implement whereby the Bureau as a Federal agency is moving to bring about a more constructive use of land in depressed rural areas. Analysis of the problems of each area, however, and the determination of the best methods of attack, demand consideration of a host of diverse factors varying from economic classification of land to land tenure and the financial problems of local governments.

Provision for the planning of adjustments in submarginal areas is given in title III of the Bankhead-Jones Act which includes an authorization for the Secretary of Agriculture "to cooperate with Federal, State, Territorial, and other public agencies in developing plans for a program of land conservation and land utilization, to conduct surveys and investigations relating to conditions and factors affecting, and the methods of accomplishing most effectively, the purpose of this title, and to disseminate information concerning these activities."

The development of a national program of this character involves, first, the examination of the problems of present maladjustments in land use. Such evidence as low rural incomes, excessive dependency of and occupants upon public relief and other types of public assistance, and the inability of the lands to support roads, schools, and other public services and institutions, as indicated by chronic tax delinquency and a high level of State aids in proportion to taxes collected, are among the outward symptoms examined.

Second, planning involves an economic classification of the various types of land in the areas of maladjustment, to determine the uses to which they are economically and socially suited, and the population they might be expected to support at a given standard of living under these uses.

The third step is to determine what forms of public action will best serve to bring about and maintain the uses of land shown to be desirable by the economic land-use classification mentioned above. The measures to adopt and encourage in cooperation with State and local agencies will vary with different locations and situations. Such measures may be Federal and State purchase; State and local public land acquisition through modification of existing tax-delinquency and tax-reversion procedure; public direction of private land use through rural zoning, or establishment of soil conservation districts; guidance in the more judicious use of public and private credit; or improvement in farm leasing arrangements.

Fourth, there must be coordination of Federal-State land conservation and land utilization programs of action. Many of the means for preventing or eliminating the misuses of land fall within the domain of autonomous State action. A great many of the States have become conscious of the land-use problems within their boundaries and have undertaken the formulation of policies and programs designed to correct land misuse. The attainment of the objective of a national program of land conservation and land utilization will require, therefore, a close cooperation of the Federal, State, and local Governments in the development of coordinated action.

The initial basis for planning the land-utilization program was laid in the soil surveys and other physical inventories which were begun by the Department of Agriculture and other Federal and State agencies half a century ago, and by the farm-management surveys and standard of living studies which have been conducted by the Bureau of Agricultural Economics and the State agricultural experiment stations during the past two decades. The economic aspects of land-use planning were greatly advanced by the work of the original Division of Land Economics, which was established in the Department of Agriculture in 1919.

More recent contributions to this field of planning were the land-planning activities established under the

¹ In Charge, Division of Land Economics, Bureau of Agricultural Economics.

Agricultural Adjustment Administration in 1934 and the National Resources Board. Functions of both these agencies were merged in the Land Use Planning Section of the Resettlement Administration. Following the transfer of the submarginal land program to the Bureau of Agricultural Economics in 1937, the Land Use Planning Section was merged with the Bureau's Division of Land Economics. The Divisions of Farm Management and of Farm Population and Rural Life have been brought into close association with the land-utilization program, contributing much to its planning work. The Division of Land Economics now consists of five sections—land classification, land appraisal and valuation, land policies, water utilization, and flood control. A small staff of technicians is maintained in each of about 40 States, usually at the agricultural experiment station.

Among the first activities undertaken in this planning program was preparation of a series of land-use problem-area maps, showing areas in which various types of adjustments in land use appeared desirable. The most important of these maps are those showing areas in which farm problems appear to warrant encouragement of a change from crop farming to stock ranching or forestry, or other conservational uses for all the land on some farms or all the farms in some localities—the so-called “land retirement” areas; and those showing areas in which many of the farms should be larger in order to provide an adequate family living and at the same time permit soil maintenance. Since their first preparation, which was accomplished in a few months, these maps have undergone refinement and revision. They still are being refined in small areas as local or regional land classification or land-use studies furnish more facts upon which to base the problem-area boundaries.

The focal point of the land-utilization planning work has been the area program—a survey, usually covering one or more counties in a State, to determine what devices or measures can be applied to bring about the adjustments in land use which appear to be desirable. One such study recently was completed in Forest County, Wis. Land in the county has been classified according to what appears to be its desirable economic uses, and changes in the present pattern of use and occupancy which are necessary to secure substantial conformity to the desirable economic use have been pointed out. Various means of effectuating these adjustments have also been explored, not as isolated measures, but as interrelated measures in a coordinated program. In the case of Forest County a rural zoning ordinance is already in effect, but certain changes in zone boundaries have been suggested to include more

nearly all the territory in which agriculture or year-round residence should be discouraged or discontinued. A plan is outlined for relocation of isolated nonconforming users in zoned areas; this is for the purpose of reducing costs of public services to supplement the purchase program already undertaken. The possibilities for effecting savings through county consolidation are analyzed, and alternative plans for township consolidation are set forth. Programs for Federal land purchase are analyzed in the light of their expected effect upon local economy.

Frequently such a study will unearth some State law or local administrative procedure which is helping to perpetuate the occupation and use for farming of inferior farm land. A survey in Brown County, Ind., for example, revealed the fact that State school funds, accumulated from various sources, were required by State law to be invested in farm mortgages. The money was loaned indiscriminately by county officers on good and poor land. Losses were heavy in the poor-land areas; and, because the county was responsible for interest payments to the State school fund for funds placed in the county under mortgages on farm land, those losses resulting from loans on poor land were a heavy drain on all the taxpaying lands of the county, thus encouraging tax delinquency. Availability of this credit undoubtedly permitted many farmers to remain on poor land many years longer than they could have had no such easy money been available. As a result of an exposition of this situation, remedial legislation has been proposed which would withdraw school funds from the farm-mortgage field and provide for their safer investment—an instance of cooperation with States for action to promote better land use.

Suggestions for sites for submarginal land purchase originated from these surveys. Such studies also indicate how large a part public purchase should play in any single land-use adjustment project—whether it should bear the brunt of the adjustment or play only a minor part—and what corollary measures are necessary to effect desirable adjustments on intervening or surrounding lands that should or will remain in private ownership. For example, in the Wisconsin area just cited, public purchase of a few scattered tracts would greatly expand the effectiveness for land-use adjustment of the zoning ordinance already existent there and, conversely, the existence of the zoning ordinance makes unnecessary the purchase of more than a few scattered tracts. In some other locality, a desirable adjustment program might demand practically solid purchase of an entire area.

(Continued on p. 48)

By Dillon S. Myer¹ and L. C. Gray



WATER FACILITIES AND LAND USE IN DRIER AREAS

THE PASSAGE of the Pope-Jones Water Facilities Act² gave Congressional recognition to "... the wastage and inadequate utilization of water resources ..." which occur in the arid and semiarid parts of the West because of "... inadequate facilities for water storage and utilization." The act established a new policy for rendering Federal assistance to individuals in providing such needed facilities. To effectuate this policy the Secretary of Agriculture was authorized "... to formulate and keep current a program for projects for the construction and maintenance ..." of small water facilities in these areas. The act allows the location of these facilities on federally owned or controlled lands, but also "... on any other lands upon obtaining proper consent or the necessary rights or interests in such lands." By allowing the program to extend to individual farms and privately owned range land the restriction on Federal participation is liberalized to an extent which will allow that aid be given directly to farmers and ranchers who need such facilities.

Although additional water facilities are needed in most parts of the arid and semiarid region even in years of normal precipitation, they are more urgently needed during the frequent drought periods. Because of the lack of watering places for livestock, some parts of the range cannot be used to advantage even during normal years. The land around large numbers of water holes is overgrazed to an extent which allows erosion, while grass a few miles distant from water is not completely grazed. In years of low rainfall when some of the water holes become dry, water shortage is more acute, and the improperly utilized range area is much more extensive.

In dry-land farming areas, wells go dry during extended drought periods. This necessitates the hauling

of water for domestic and livestock use even though water may escape from the area and cause floods during parts of the year. During dry periods the grain crop upon which the farmer depends primarily for his income fails to produce adequate yields, his garden dries up, and the yield of his forage crops is so light that he has insufficient feed for his work stock. Adequate small water facilities could assist these farmers to some extent in alleviating these conditions.

Under Federal programs other than that of the Department of Agriculture some types of small water facilities have been provided, in recent years, in the arid and semiarid regions. For various reasons the personnel for careful planning and for adequate supervision of construction usually was not available, and many of the facilities therefore did not fulfill the purposes for which they were intended. Some of these programs were confined to the construction of facilities only on Government owned or controlled lands. While facilities could be provided for specific areas under this type of program, no assistance could be given to farmers and ranchers outside the areas to help them in solving their individual water-supply problems.

Under those Federal programs which were designed primarily to furnish work relief, some types of small water facilities were constructed. It was necessary to employ maximum loads of relief labor as quickly as possible and sufficient supervision often was unavailable to assure that these facilities were properly located to serve the area adequately, that there was an adequate water supply, and that they were properly constructed. Under a purely work-relief program, there naturally has been the tendency to construct an overabundance of facilities in the vicinity of ample relief labor, and too few in localities where relief labor was scarce.

¹ Assistant Chief, Soil Conservation Service.

² Assistant Chief, for land utilization, Bureau of Agricultural Economics.

³ Public, No. 399, 75th Cong., 1st sess.

A limited amount of assistance, principally in the form of loans or benefit payments, has been afforded to individual farmers under still other Federal and State programs. In general this type of assistance also would have been more effective had it been practicable to exercise a greater degree of technical supervision.

The water-facilities program is aimed toward overcoming these difficulties by carefully planning the program in advance, and by furnishing adequate supervision during construction. With a primary objective of obtaining a more efficient use of water in coordination with land use, and with authorization to assist individual farmers and ranchers, a sound and more complete use of the meager water supplies of the arid and semiarid regions should result.

Water supplies occur in what might be called units consisting of water from common sources. The unit for surface water supply is a watershed or drainage basin, and that for ground water is a ground-water province. For this reason, in planning the utilization of surface water, the supply of the entire watershed or drainage basin must be considered. In planning ground-water use, attention must be given to the supply of the ground-water area. Plans for the development of small water facilities, therefore, should be in accord with the general water plan for the watershed or ground-water province. These small facilities in the upper reaches of a watershed should complement the large downstream works in the control and use of water.

Most of the surface water supplies of the arid and semiarid regions are not subject to use for new water facilities. This is because they have been previously appropriated and put to beneficial use. Nearly all the perennial flow of the streams is covered by water rights. The water available for this purpose, therefore, is limited mostly to small amounts of ground water in localities where it is available at reasonable depths, to intermittent flow originating in snow-melt in the spring, and to storm waters.

Development of small water facilities should contribute materially toward attaining proper land use in these drier areas, and they should be planned and constructed in a manner which will assist individual farmers and ranchers in attaining this objective. In fact the program under the Water Facilities Act must be aimed toward attaining this objective, for the act specifically states that "the facilities to be included within such program shall be located where they will promote the proper utilization of lands and no such facilities shall be located where they will encourage the cultivation of lands which are submarginal

and which should be devoted to other uses in the public interest."

To accomplish desirable adjustments in range-land use, water facilities will be constructed under this program for furnishing livestock water, for the spreading of intermittent surface run-off for pasture irrigation, and to irrigate small areas for the production of feed crops.

In the drought area, where rainfall is low or variable, ground water is often a more stable and dependable source of stock water supply than are intermittent streams or normally dry water courses. Large impounding structures which will hold storm waters over long dry periods, with allowance for seepage and evaporation losses, will usually be expensive. Where ground water is available in springs or at relatively shallow depths, therefore, it can usually be developed at more reasonable costs. In such areas spring and well development will probably become a relatively important feature of the program. Where this is not practicable small reservoirs should be constructed to impound unappropriated surface run-off for livestock water.

The location of watering places on the range is an important element of water-facility planning. Where feasible within the physical limitations imposed by nature and at costs commensurate with the development of lands for such an extensive use, water holes should not be so far apart that livestock are required to travel long distances. On the other hand, they should not be so close together as to duplicate facilities within a given range area. On range with a low carrying capacity, the construction of what might ordinarily be considered a desirable pattern of watering places cannot be economically justified. But on better range land, where construction of stock-water reservoirs is the most satisfactory type of development, such facilities should normally be spaced about 4 miles apart. These primary water facilities frequently may be supplemented by small relatively low-cost structures which will aid in spreading the livestock more evenly over the area during a part, at least, of the grazing season.

Water emanating from small draws or coulees, before it has reached a well-defined channel, may be diverted and spread over range land to increase the yield of grass.

Another type of project would provide for the irrigation of units ranging from a hundred or less to a thousand or more acres. Ordinarily, dams will be built to regulate stream flow and to release water during the irrigation season to be diverted or pumped

upon the land. In most cases the water will be used to grow hay or forage crops, thus augmenting feed supplies for range stock. This will allow a larger number of livestock in an area without increased overgrazing, and will contribute to the rehabilitation of overgrazed lands by shortening the seasonal grazing period. Or it may permit the accumulation of feed reserves, during normal years, to be used in periods of drought when feed supplies are depleted.

Projects to increase the amount of pasture or of feed crops will facilitate the adjustment and stabilization of large surrounding areas of grazing land. Grazing districts or groups of cooperating ranchers may obtain through this program the type of water facility which is best suited to their needs and to the physical possibilities of the area.

Water facilities for farms may include some water supplies for pastures but will probably consist mostly of spring and well development for furnishing domestic and livestock water supplies on farmsteads. Where water supplies are sufficient, small irrigation facilities may be constructed to assure ample farm gardens and some feed for work stock. Where additional water supplies are available which may be developed at reasonable costs, these small irrigation facilities may be enlarged to allow an increase in farm livestock numbers and the inclusion of cattle for supplying the family with dairy products. This should be of material advantage, particularly in years of very light precipitation. To be of most value, these water facilities must be carefully planned to determine that water supplies will be available, to make the most efficient use of the limited water supplies, and to construct dependable facilities at reasonable costs. Since very few dry-land farmers are familiar with irrigation, the location and design along with supervision of construction and instructions for use and maintenance of the small irrigation facilities must be governmental functions.

The farmers of the semiarid parts of the West have become decidedly water-minded during the recent droughts. Many feel that their difficulties can be solved entirely by obtaining plenty of water. Experience has shown, however, that water supplied artificially must be obtained at reasonable costs to allow successful farming. In planning the water-facilities program, therefore, facilities must be furnished at costs within reasonable economic limits.

A program involving merely the construction of facilities for the conservation and use of water is not sufficient to assure the continuation of benefits from the facilities. The success of any such program is

closely allied with provision for maintenance of the structures, and the Water Facilities Act provides authorization for this maintenance. Although farmers who obtain facilities under this program must be willing to maintain them, provision for maintenance of the smaller facilities will present only minor difficulties. For irrigation facilities the annual cost of maintenance and operation is particularly significant. For the larger facilities, definite agreements to provide proper maintenance may be required under the provisions of the act.

Provision has been made to aid individual farmers and ranchers of the West in securing badly needed small water facilities, but they cannot all be supplied during the first year of the program. It is expected, however, that the program will continue in a well-planned, orderly manner in order that the water resources of the arid and semiarid West eventually may be utilized to the fullest practicable extent as a necessary auxiliary to the other resources of the region.

PLANNING FOR THE LAND UTILIZATION PROGRAM

(Continued from p. 45)

Recommendations for land-purchase sites describe briefly the present land use in the area, outline the nature, extent and seriousness of existing land-use problems, explain how public land purchase will contribute to the solution of these problems, and indicate the corollary measures needed to supplement the purchase program. They describe the character and estimate the area of the lands recommended for purchase, outline the proposed uses of the lands after purchase and locate the project area with respect to other land areas now under some organized public ownership or control.

To draw up detailed plans for submarginal-land purchase projects, which will provide well-rounded plans of adjustment for specific areas, within the general framework of recommendations described above, is the task of the Division of Project Organization. That Division is responsible for determining the exact boundaries of a project, and for selecting the tracts of land within these boundaries which should be purchased in order to facilitate the general plan of adjustment previously determined. A concrete plan for the future use of the area is determined upon, and general plans for improvement of the area are drawn up. Likewise, provision for future management of the purchased land is made which will ensure that the program of adjustments will be completed.

LAND TREATMENT AND THE CONTROL OF FLOODS

By

E. N. Munns¹

THE American citizen has asked for flood control at the source—the control of little waters. And because the management and treatment of the land affect the run-off waters, the Department of Agriculture is drawn into the picture.

The Flood Control Act of 1936 recognizes land treatment as a real factor in flood control. Although a new statement of policy, such an objective is no new story to the Department of Agriculture. Prior congressional acts recognized different phases of water control; for example, the Weeks Act of 1911 authorized purchase of lands at headwaters of navigable rivers; the Clarke-McNary Act of 1924 authorized protection and reforestation for flood control; the Soil Conservation Service Act of 1935 enumerates flood control as one purpose of the unit; a long line of appropriation acts specify water control as the objective. However, the implied coordination and integration in this flood act is new. Under the new program the Department is attempting to reorient its various activities so as to achieve correlation and integration within the framework of its existing organization. But how is this being done?



One of the millions of land-slashing, downhill rills which, collectively, help to create floods and which, singly, as here, help to focus attention on the necessity of watershed treatment and upstream engineering.

First, a Flood Control Coordinating Committee has been established. This brings actively together those bureaus in the Department most intimately concerned with the land action program. This includes both the Forest Service and the Soil Conservation Service, direct-action agencies. Because the Flood Control Act specifies that flood-control programs must rest upon an economic base, the Bureau of Agricultural Economics is added. This Committee reports policies and programs to the Secretary through the Office of Land Use Coordination. Other bureaus having an interest in the flood problem but not so immediately involved in the action program or in its economic base in the fields of their special interest are advisory to the Committee.

Second, because the program is so huge (Congress has authorized studies in every State and in Alaska), and because correlation begins on the ground, regional field coordinating committees have been established throughout the country. Membership on these field committees is the same as on the main committee. These field committees recommend the specific local program needed and develop the local plans for the work.

Now the Flood Control Act of 1936 does more than merely establish the Department of Agriculture as the agency to do supplementary flood control on a watershed basis. It also does more than merely specify the watersheds in which the Department should work. By using terminology which has been applied to definite procedures in vogue by the Corps of Engineers, it outlines the three steps involved in a program. These steps are: (1) A preliminary examination of watershed to determine the feasibility of a flood-control project; (2) a detailed survey of the critical areas in the watershed to develop the concrete action program and to determine its cost and benefits; and (3) the actual flood-control operation. The first two are planning, the third is action.

The first stage in the procedure is a preliminary examination of a watershed. This examination by the field coordinating committee determines the extent of the flood problem, the damages done, the flood source areas, and whether or not there appears an opportunity for an upstream program. This study is made rather quickly, but with sufficient care and detail to demonstrate within reasonable limits that the flood problem is of such magnitude and character as to warrant a land program. It starts with three assumptions:

¹ Chief, Division of Forest Influences, U. S. Forest Service.

(1) That the public has a definite responsibility for sponsoring a flood-control program; (2) that the benefits of control will exceed the cost unless lives and social security are directly involved, and (3) that the local people are sufficiently interested to be willing to participate actively in the program.

In determining these facts for a given watershed, the field committee obtains certain factual data as to the crops, cover, soil, and land use within the area, analyzes data on the precipitation and run-off, determines the frequency of floods and the extent of their damage, and looks into problems of occupancy and use of watershed lands that bear on the flood problem. In this examination, flood-source areas are located and the possible application of remedial measures suggested. Public hearings are held (in cooperation with the Army engineers) to obtain the local viewpoint and to determine who it is that wants protection, where, and why, and whether local participation will be forthcoming.

On the basis of their findings, the regional field committee decides either that no flood problem exists that can be cured by an economic upstream control program, or that such a problem does exist and can be so cured. A brief report on the watershed is prepared with the committee's suggestions and transmitted to Washington. Copies of this report are then circulated among all the interested bureaus for comment and criticism. Upon the basis of these comments and its own review, the Departmental Flood Control Coordinating Committee determines whether or not the report is satisfactory. If so, the field committee recommendations are upheld. Should the report be favorable to a detailed survey, a recommendation to this effect is made to the Secretary. Should it be unfavorable, the report must go to Congress in order to discharge our responsibility. In such cases, rather full reasons must be given for the action to avoid controversy with those individuals who may be interested in a particular local situation.

Is it possible that places exist where upstream control is not justified? Indeed yes. For example, floods may occur in tidal estuaries due to exceptional high tide and regardless of any device man might build upstream. Floods occur when hurricane winds blow the water out of the lake on to the land as they did a few years ago in southern Florida. Floods may occur under certain conditions in a densely forested drainage, but the damage caused may be so small as not to justify special treatment. Or, floods can occur in a stream discharging directly into the ocean or a great lake without causing any appreciable damage, as might

be the case with certain streams in the northern part of the Lower Peninsula of Michigan.

Under a detailed survey, the specific land action program is determined. This calls for an exacting study of the watershed and its problems. Whereas the findings of the preliminary examination report were based largely on opinions and sketchy data, the findings of the detailed survey must be based upon demonstrable facts. For this reason, the survey becomes a land-planning survey. Studies are made of air photos to reveal local conditions and the need for curative methods. Soils, hydrology, cover, and engineering must all be considered in developing the plan. The final plan must prescribe the methods whereby flood control is to be attained. It must outline for each portion of the watershed requiring attention the nature of the various forms of treatment, which one or ones or which combination of treatments should be utilized, where and how they should be applied, and their estimated cost, and the physical, economic and other benefits to be derived from them. The survey must consider all forms of land use and adjustments. Finally the treatment proposed should be within the economic limits set for it.

In developing the plan great skill is required because a positive separation must be made between those measures having a direct benefit in the flood-control program and those possessing auxiliary benefits but not otherwise justified on the basis of flood control as such. Similarly also, a separation must be made in the application of these same measures as between those parts of the watershed where the measures are needed for flood control and those where they are needed because of other social or economic considerations. On some of the flood-source areas an immediate program will be indicated. On others conditions may be such as to suggest that the program be deferred until the more critical situations have been met.

Under the procedure used by the War Department detailed plans for specific works of improvement are submitted to the Congress for consideration. These plans are reviewed in the House Committee on Flood Control. If the plans are accepted, Congress authorizes by legislation a special flood-control project to be undertaken in accordance with the recommended plan. Following the authorization Congress appropriates the money to carry on the work.

For its upstream control operations the Department of Agriculture is now authorized to follow another procedure. Under the Whittington Flood Act of June 28, 1938, the Department has received authorization in advance of the submission of plans to do work

on watersheds of those streams for which the War Department has already been authorized to perform certain works in the interest of flood control. Thus Congress, by legislative enactment, has requested full integration of programs between the Departments of War and Agriculture.

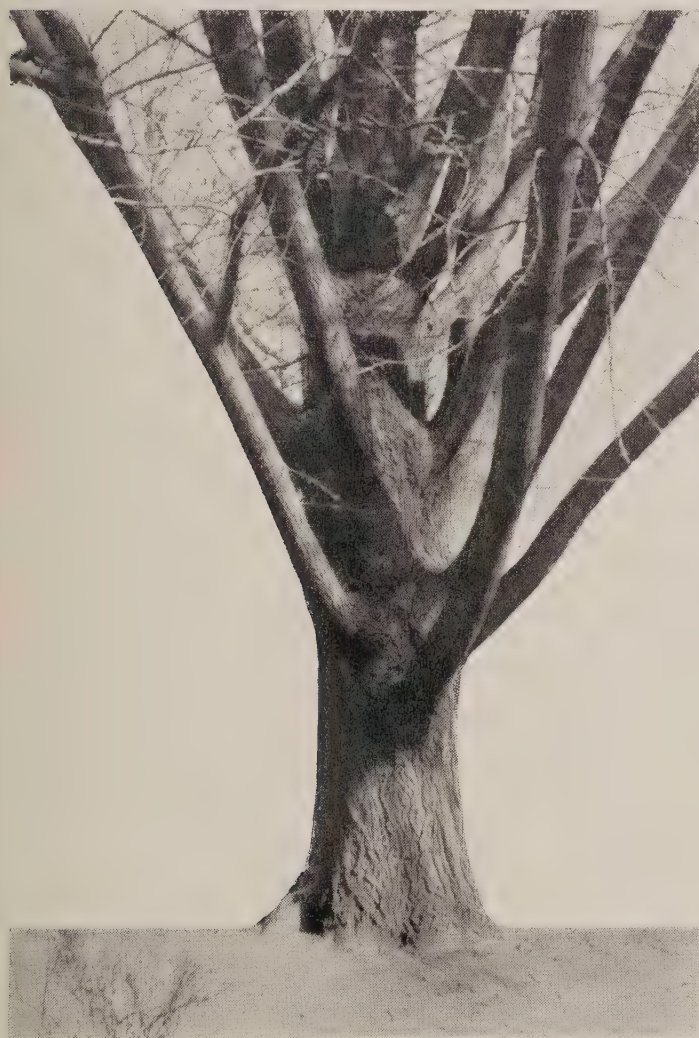
To date, this integration exists more on paper than in reality. For many years the Corps of Engineers has been developing its flood control plans for the major river systems. For years the engineers have been perfecting their specific action programs. Consequently, they can go forward rapidly with an action program on many streams. In the meanwhile, Agriculture must proceed slowly, gain experience, and train personnel as it develops its action program.

The job ahead for the Department of Agriculture is a big one. For the preliminary studies it involves practically 90 percent of the land area in the country. For the detailed studies it involves a large number of troublesome streams from Maine to Texas and from Florida to Alaska. It involves concentrated planning on a large scale.

The job ahead is a difficult one. It involves all kinds of land—flat, hilly, and mountainous. It involves all kinds of crops—hay, tobacco, peanuts, cotton, corn, grapes, citrus, etc. It relates to all kinds of land ownership—nonresident owners, small owners, tenants, sharecroppers. It touches our polyglot nationals of all races, creeds, and historical background.

Dependable Forests—Especially Farm Forests

By E. H. Clapp¹



THE best attainable data indicate that the 48 States contain about 615,000,000 acres of forest land—498,000,000 acres suited to timber production on a commercial scale and 117,000,000 acres supporting semiarid or subalpine types chiefly of protective or scenic value. Ownership is wide and diverse; for ex-

ample, there are 2½ million farmers who own woodlands aggregating 185,000,000 acres, plus many others whose farms would be benefited by plantings of farmwoods or shelterbelts. Forest owners other than farmers number hundreds of thousands. Future forest economy will directly affect possibly a thousand different counties or parishes, most of the States, the majority of the railroads, many other quasi-public and private institutions, thousands of dependent communities and millions of dependent people.

Forestry planning is thus an imperative and inescapable necessity, embracing (a) broad plans upon which to found general programs of national action; (b) plans of greater refinement to serve as bases for regional adjustment; (c) more specific plans for the management of lesser areas; and (d) plans of technical refinement for the guidance of individual timber operators, especially owners of farm woodlands.

In such processes of planning, farm forestry influences and is influenced by every other phase of forestry. Farm woodlands now comprise 27 percent of the Nation's entire continental forest area. In average productive quality they presumably equal, if they do not excel, the other 73 percent, and logically should provide at least one-fourth of all future timber production. Techniques of marketing thus rank in importance with techniques of silvicultural management, and the future status of the farm woodland as an appreciable element in farm economy may depend perhaps as much upon the conditions created on the nonfarm forest lands as upon those created on the farm wood-

¹ Associate Chief, U. S. Forest Service.

lands. Additionally, stable wood-using industries may be the paramount means to create local markets for farm crops or for off-season use of farm labor and equipment.

Dependable planning requires dependable knowledge. Procurement of such knowledge consequently is the initial phase of planning. The forest knowledge of the United States until recently has been largely empirical—to some degree mythical. The experience of countries in which intensive forestry has long been practiced discloses the kinds of knowledge requisite to its effective employment as an agency of social progress and economical security, but does not supply the knowledge specifically applicable to the forest type, soils, industries, social groups, or economic and political institutions, peculiar to the United States. That must all be developed, almost *de novo*, hence forest research is a major and indispensable element of all forest planning. In the Forest Service, research is planned along a wide front.

Studies of the economics of forestry are under way. They are designed to determine trends in lumber prices and in stumpage values; to calculate the costs and returns from forestry enterprises under a variety of conditions; to inquire into the status of forest-land zoning in the present organized political units; to decide what parts of the forest must be set aside for special uses such as recreation; and to ascertain the relationship of the forest to community development. One major phase of such economic studies is the forest survey, a national undertaking designed to determine the available and potential supplies of our timber resource, its location and distribution, whether or not nationally and regionally we are depleting our resource, and the present and prospective requirements for forest products—all basic to forest-land planning.

Forest-management research endeavors to determine the silvicultural practices and methods to be used in establishing, growing, tending, and harvesting the forest crop. It includes investigations of the seed and the tree, its heredity and modifications which can be made in it, the relation of the tree to its environment, and studies of the cutting practice in order to obtain the natural reproduction of the stand. It also endeavors to develop a proper understanding as to the use and control of fire in the forest. The results of such investigations bear very directly upon all planning for forests of the future.

Forest products research aids in planning for the future by developing better utilization practices in order to help balance our future timber budget.

One of the forest products is range forage. Without a knowledge of the proper use of this forage and the relationship between the minor vegetation and the forest, the harvesting of the forage by livestock can not serve its purpose in community welfare, and it may cause difficulties in reproducing the forest. To meet this situation and many other problems requires investigation of the range forage and its management.

The manner in which the forest is handled will affect the usability of its water resources for various purposes; hence, investigations are under way to determine the relation between cover conditions and water supplies so that management plans may be developed which will ensure uninterrupted supplies of usable water.

Thus, forest research has many objectives, all of them bearing directly upon the development of plans for the future.

Broad concepts of national interest in forest lands require specific action by the actual owners of the lands. Where such owners are individual citizens, this is a cooperative process in which function the State conservation agencies, State foresters, land-grant colleges, State extension services, county planning committees, organized soil-conservation districts, etc., with Federal cooperation in technical services sometimes supplemented by financial aid.

Among the objectives thus approached are (a) more adequate protection of forests against fire, insects, and disease; (b) provision of forest planting stock for farmers, in which 40 States now cooperate under the Clarke-McNary Act; (c) activities authorized by the recently enacted Cooperative Farm Forestry Act—e. g., extension services, technical assistance, cooperative marketing of farm forest products, and development of sustained-yield management programs to stabilize industrial and community life; (d) systematic and organized programs for planting of field shelterbelts, woodlands, and stream-bank and livestock protection plantations, supplemented by water-impounding dams surrounding plantations for water conservation with associated recreational potentialities; and (e) adoption by wood-using industries of better cutting practices. The general approach is to enlist the support of and associate together in cooperative relationships all the various agencies and parties involved; to determine upon the steps that are desirable and practicable of adoption; to devise feasible means of adoption; to make them widely known; and to create the conditions under which they will work.

Coincident with the scientific, advisory, and cooperative phases of forest planning for private lands are

those of planned resource management exemplified by the national forests. Planning for the protection, development, and use of the national forests is complicated by the wide diversity of problems and interests relating to their management. This is exemplified by such widely diversified conditions as are found in the old-growth forests of the Pacific Northwest, in national forests which have been established in exploited cut-over regions of the Lake States, with their stranded communities and populations, and in national forests in the South which are characterized by productive pine lands, poor farms, and rural poverty.

National forests in the devastated and cut-over regions require planning for the rehabilitation of both the physical and human resources with the greatest possible provision for permanent employment. Planning for the already productive national forests entails the same objectives, but without awaiting resource restoration.

Particularly in the national forests of the South and the northern Lake States, planning is directed toward a closer relationship between farming and forestry. Although these two regions are predominantly forested, they embrace one-half of the farms in the country. Within their limits, forestry as a supplement to farming operations offers definite promise of increased income and better living for farm families. In addition to the integration of farming with forestry in the national forests, forest-management planning requires the definition and evaluation of all beneficial uses inherent in the national-forest resources. It requires, furthermore, the development of plans of management which will recognize and encourage the widest permanent utilization of the resources in ways benefiting the greatest number of people.

The intensely intricate and complicated character of the forest as a biological entity compelled the Forest Service, early in its administration of the national forests, to recognize the indispensability of over-all or area management of forest lands for all beneficial uses, rather than a uni-functional form of management. This form of management requires a decentralized organization which, in turn, requires administrative planning that will foresee changing needs, provide the national forest administrator with sufficient freedom of action to enable him to deal with local problems locally, and ensure fair and equal treatment to all forest residents and users.

Within the national forests and their zone of influence live hundreds of thousands of people whose ways of living are directly influenced by the processes of national-forest administration and management.

As public forest lands, the national forests must be so managed not only to safeguard the Nation's timber supply and assure favorable conditions of streamflow, but also to ensure the welfare of the dependent peoples.

PLANNING THE A. A. A. PROGRAM

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considered. This means, of course, that the particular idea or plan advanced by any one individual or group can rarely be adopted without some change or modification when the interests of other individuals or groups are considered.

But the essence of democratic planning, under the method of program development which the Agricultural Adjustment Administration endeavors to follow is to be found in full and free discussion by all interested parties. All questions involved are thus discussed so that the farmers, the consumers, and the technicians may all be aware of the many interests affected, and of the reasons underlying the decisions which must finally be reached and written into forms and rules and regulations for the administration of the program.

OVER-ALL PLANNING, THE NEXT STEP

(Continued from p. 34)

agriculture. With this structure built and functioning, and with its responsibility recognized, agricultural agencies will be ready to put their full weight behind the next vital step in planning: the coordination of agricultural planning within itself, with industrial planning, transportation planning, urban planning, and with planning for those other big divisions of the American economic and social structure that together constitute another and much more difficult and complicated level of "over-all" planning.

THAT SOILS AND WATERS MAY REMAIN PERMANENT ASSETS

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Thus, the apex of Service activity is now being moved away from demonstration areas toward districts, with cooperation the keynote. The ultimate growth and area of districts are, of course, matters of conjecture. Yet it is entirely conceivable that within the next decade they will cover a substantial segment of the country's erodible land. If this possibility materializes, no better avenue than the district will be available to the Service, and to other governmental agencies, for encouraging Nation-wide soil conservation and better land use. Looking to the future, Service planning considers such an eventuality.

HIGHWAY STUDIES SERVE MANY USES

By T. H. MacDonald¹



Automatic traffic recorder in Oregon.

Speed and safety characterize this arterial highway of the West.

Inset shows loadometer weighing operation.

THE ARTICLE "Roads to Market," published in the July issue of SOIL CONSERVATION, sketched the history of the Department's highway program and the background of the highway planning surveys begun in 1935 and now being carried on by 46 State highway departments in cooperation with the Bureau of Public Roads. In the following paragraphs are described the objectives of the surveys, the methods followed, and the progress made to date.

The primary objective of the surveys is to provide the facts needed in developing and maintaining an adequate national highway system. These facts include (a) the present extent and condition of all our rural roads; (b) the service rendered by the various parts of the road system; (c) the relation of road costs to the benefits obtained by road users; and (d) means by which we may meet the continuing cost of an adequate highway system.

The highway planning surveys are not projects to be closed within a scheduled time, but rather a continuing function of each State highway department and the Bureau. The intensive studies described herein make up a program of work to be accomplished within a definite period, but the data obtained in them must be kept current by continued studies from year to year if they are to retain their value.

The present extent and condition of the roads is measured by the rural road inventory. Records are made of the length, width, type, and condition of pavement of all rural roads; dimensions and condition of structures, such as bridges; the location and type of

dwellings, stores, and other culture along the roadside; and the location, type, and condition of crossings, whether at grade or separated. Insufficient sight distances, excessive grades, and inadequate super-elevation on main roads are noted. Special studies of railroad grade crossings both in cities and on rural roads are made in order to determine the order of priority of grade-crossing elimination projects. All these data are plotted on maps and summarized in statistical tables.

The service rendered by the various parts of the road system will be determined through the traffic surveys, which include traffic counts, weighing of vehicles, studies of origin and destination, and loading practice studies.

Traffic on main or primary highways is counted at key stations, where fourteen to eighteen 8-hour counts are made at different hours and on different days of the week. The whole schedule thus provides for the acquisition of samples of traffic under all conditions with its hourly, daily, weekly, and seasonal variation for a full year.

The traffic on the secondary and local roads is sampled by blanket counts made at a much greater number of points but less frequently.

The third important means of measuring traffic is the automatic traffic recorder. These devices, designed by engineers in the Bureau of Public Roads, are a very practical application of the photoelectric cell. At present, engineers of the Bureau are working on a design for portable automatic recorders using a different principle of operation. These will be used to supple-

¹ Chief, Bureau of Public Roads.

ment the photoelectric recorders, which are most effective at permanent locations.

The traffic counts represent only a part of the study of service rendered. Portable scales called loadometers are used to weigh trucks and busses at certain key stations simultaneous with the making of the key station count. The data obtained include registration numbers, the nature of the commodity or the number of passengers hauled, the weight of the load, the origin and destination, and the type of origin and destination—as farm to railroad, factory to retailer, etc.

In addition to these studies of commercial vehicles, origin-and-destination studies of private-car movements are made at some loadometer stations. Other studies of this type are to assist in determining the value of or necessity for bypass routes around congested areas.

Pit scales located at three or more strategic points are used to obtain very accurate weights of commercial vehicles and loads. The pit scale parties also measure the over-all length, maximum width, and height of the vehicle and its load, and record tire sizes, axle loads, etc. The purpose of these studies is to determine what loading practices are actually followed and found most economical by haulers—this in view of the fact that many State laws restricting the size and weight of vehicles are known to have no scientific basis and to lack uniformity.

Certain other studies which have been aptly described as relating to the dynamics of highway traffic—as distinguished from its volume and the weights of its units—have recently been added to the program. They include investigation of hill-climbing ability of motor trucks and tractor-trailer combinations, studies of speed of vehicles, and of highway capacity.

The financial survey will produce most useful data on the relation between road use and the price paid for it by the user, and the all-important information the States and the Federal Government will need in the financing of our future highway program. The fiscal study analyzes the receipts, expenditures, and debts for all purposes of the State and its subdivisions, and shows the relation of highway income and expenditure to that for other purposes. The motor-vehicle allocation study, carried on by means of questionnaires addressed to car owners, shows the urban and rural distribution of taxpaying car owners. The road-use study, consisting of personal interviews with representative car owners, arrives at estimates of total yearly travel and gasoline tax payments, the extent to which each car owner uses different classes of roads, i. e., city streets, main highways, and secondary and local

roads. The road-life study is an application of the actuarial methods used by life-insurance companies, by which the probable life of pavements may be estimated from the pavement-life histories found in State highway-department records.

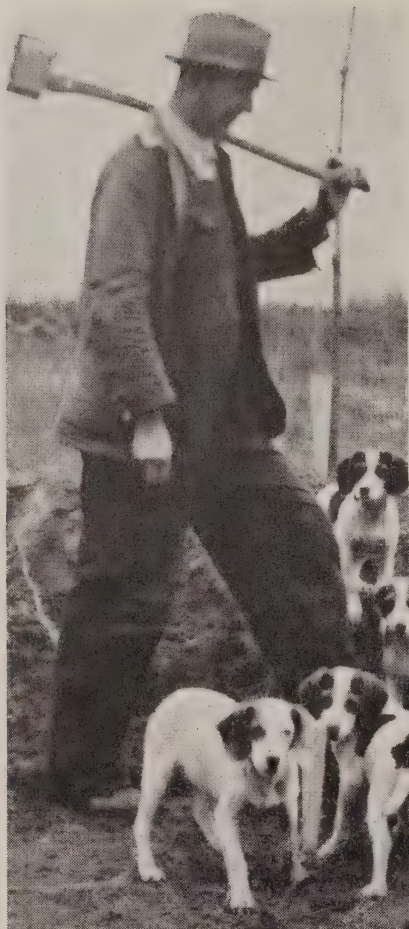
That transportation, and especially highway transportation, is a vital factor in our present economic and social scheme, is so obvious that it hardly need be mentioned. It is equally obvious that any really comprehensive study such as the highway planning survey is in itself a very important phase of general economic and social planning, and, as such, must take into consideration all the other phases which highway transportation affects and by which it is affected.

The detailed county-by-county study of the roads, their traffic, and the problem of financing them must be accompanied by a detailed analysis, county-by-county, of data on economic and social characteristics.

Highway transportation and the other factors in our present scheme of living are so interwoven that any planning study must coordinate the activities of many agencies. The Bureau of Public Roads is at present engaged in developing study outlines and suggestions for detailed analyses of economic and social characteristics; but the program is being developed in close coordination with other Bureaus of the Department, and with the intention of making full use of data which has been or is being obtained in other studies. On the other hand, the data which the Bureau and the States are obtaining and will obtain will be of value to every other Bureau in the Department, as well as to other agencies.

As one example of this general usefulness of the results of the surveys, there are the maps that are being made of every county in 46 States, showing all the highways by types and classes; all railways and their stations; all navigable streams and ports; air routes and airports; and the location of every farm, dwelling, church, school, factory, store, and recreational area outside municipalities. They show the transportation system in its entirety, and the relation of every part of it to every other part. It would be difficult to imagine any form of economic planning in which these maps would not be of real value. It is significant that the Bureau of the Census plans to use them in the 1940 census; that other Federal, State, and local agencies are finding daily uses for them; and that they are in great demand by power companies and industrial concerns. The making of these maps is in itself an example of coordination. Many of them were based on topographic maps of the Coast and

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The Land and the Perpetuation of Wildlife

By *Ira N. Gabrielson*
Chief, Bureau of Biological Survey

IN PLANNING the national wildlife restoration program the Survey seeks to provide for three requisites. The first of these is for land to be set aside upon what may be called the hereditary wildlife ranges for the preservation of all native species. From these reserves the seed stock may be drawn whenever it is necessary or desirable to restock denuded areas. Extensive game and wildlife surveys provide the information to indicate the regions where these reserves should be established with the greatest prospect of success. Provision must be made to ensure against the total loss of any species through disease or some other natural disaster that may conceivably eliminate all the seed stock on a single preserve. For example, bison are to be maintained on several widely separated ranges and similar precautions will be taken with respect to other species.

It is anticipated that seed stock from these Federal reserves may be needed to carry out State and Federal restoration programs on areas made available under land-utilization programs.

The second objective of the program is to provide for the continuation of research work to accumulate factual information applicable to current problems, and also to enable wildlife administrators to anticipate future needs. Wildlife as a resource is subjected to constantly varying conditions occasioned by many physi-

cal influences. These may be of natural origin or may result from engineering, industrial, or agricultural projects. The program is intended to furnish facts to enable wildlife agencies to obtain the most favorable results from such developments by setting up stations for regional wildlife research in selected land-grant colleges throughout the United States. Eleven of these already have been established and four more are needed to complete the project.

By attaining this objective the third requirement of the plan will also be met—that of providing for a carefully trained personnel to administer the wildlife resources of America in the future. There is now a serious lack of men who are qualified for this work. The land-grant college units will serve as research stations, and they will also offer to graduate students courses in wildlife administration similar in purpose to those offered in forestry.

The main objective of the wildlife restoration program now being developed by the Biological Survey is to prevent, if possible, the extermination of any valuable species, and to increase the numbers of such wild birds and animals to the greatest extent consistent with land-use requirements of the human population. Wildlife has a very great economic value, and it also furnishes a means for recreation and relaxation that may well become of more importance to human beings subjected to the increasing strains and stresses of modern ways of living and working than are its financial values. Several very valuable and interesting species were allowed to become extinct in those years before there was any general conception of the need for a carefully worked out wildlife conservation program that could be coordinated with agricultural and industrial activities. It is bad logic to argue that because there is no realization of a loss no loss has been suffered. The present generation of Americans never knew, nor can they ever know, the passenger

pigeon and the heath hen, and it is a certainty that modern life is the poorer for the extermination of these birds. Then, too, there is always the active possibility that the extermination of any native creature may cause grave disturbances in the complicated organic system of a country. Evidences of and realization of such damage may not appear for many years following the disaster.



Such in brief is the philosophy underlying the restoration activities and plans of the Survey. Actually these plans have been developed over a period of more than 50 years of research and study by technicians of the Survey staff. Facts slowly accumulated throughout the period were brought together, like the sections of an aerial landscape photograph, until a definite, recognizable pattern appeared. When at last the means to proceed with a program were provided, the essential needs were known as well as the methods by which they could be met.

The principal need was for land. Bird banding, food habits, and habitat studies conducted for half a century furnished precise information as to the type of land required to support each of the many different species. It was realized that, except for the habitats of such creatures as find suitable environmental conditions upon cultivated lands, most of the areas that might be devoted to the program would necessarily be of types not adapted to profitable agricultural uses, or where the soil conservation and water control effects of the wildlife management operations would be of vital importance to the general land-utilization program.

The progress already made in acquiring such areas and developing them for wildlife uses has been discussed in a previous article and needs only to be summarized here. For the minimum requirements of waterfowl, about 7,500,000 acres of marsh and water refuge areas are needed on the breeding grounds, along the courses of the four major flyways, and on the wintering grounds used by these birds. About half of the required total has now been acquired or is in the process of acquisition. The areas making up the remainder are already known and can be acquired as means are provided.

To maintain adequate stocks of nonmigratory species, including big game and upland birds and mammals in the United States, 3,968,000 acres have now been set aside and some additional lands are needed. The



Nunivak Island Refuge in Alaska includes 1,111,000 acres. The completion of this acquisition and development program will not dispose of the problem, however, since conditions governing land use do not remain stable and immutable. They must change constantly to meet the constantly changing requirements of the people, and provision for the maintenance of wildlife must be sufficiently flexible to allow adjustment.

In addition to the regular appropriations made to the Survey for research, game management, and regulatory activities, two acts of Congress now provide moderate but continuing funds for a land utilization and development program. The first of these is the Federal Migratory Bird Hunting Stamp Act which annually supplies about two-thirds of a million dollars for land acquisition and use in the waterfowl restoration program.

The second is the Federal Aid to States in Wildlife Restoration Projects Act, authorizing the annual appropriation of amounts equal to the revenues received from the 10-percent tax on arms and ammunition. The revenue from the excise has amounted to about \$3,000,000 annually. Funds appropriated under the latter measure will be allotted to the States on a cooperative basis whereby each participating State pays one-fourth of the total cost of the projects undertaken under the terms of the act.



Inasmuch as the act principally requires and specifically encourages the State conservation agencies to use these Federal allotments to acquire and develop land for wildlife purposes, it is apparent that over a period of years many millions of acres of land will be gradually added to the total area now available for wildlife. It is of considerable consequence, too, that these projects will be supervised by the Biological Survey during development, and that the Survey is fully aware of the opportunity to exert its influence to make these operations contribute to the national soil conservation program.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



Land Utilization in China, Volumes I, II, and III. By John Lossing Buck. The Commercial Press, Ltd., Shanghai; The University of Chicago Press; Oxford University Press. 1937-38.

It is suggested that before you take up this extraordinary work you journey through the land of the Tartars, now China, in the company of that thirteenth century adventurer and trader, Marco Polo. It is better to enter from the far northwest, join Mark the "wise and noble citizen of Venice" at the city of Lop and the Great Desert, follow him to Karakorum and the great plains of the North where "originally the Tartars dwelt" and where there were "excellent pasture lands, with great rivers and many sheets of water." Then take the long trail southwestward through the Province of Si-ning-fu (the name may be found still, without the hyphens, on a modern map of China) and on and on to Cathay "extending to the ocean sea." You must journey with Mark also on his travels into the Western and Southern Provinces, on errands for the "great Khan, lord of lords, whose name is Kublai," and when you have gone as far as Book the Third, "Of the Merchant Ships of Manzi That Sail Upon the Indian Seas," you may reach for Dr. Buck's book, volume I of *Land Utilization in China*, and learn what has befallen the land itself of that great area, now China, throughout the many centuries that it has been in the hands of swarming hordes who like Marco Polo's Tartars have "multiplied exceedingly."

It is best to read at least the first two chapters of volume I before referring to the statistical volume and the atlas. By the time you have finished chapter 2, *Agricultural Regions*, you will find yourself clearing a table top and pulling up a chair that you may have space and comfort for a satisfying inspection of the maps. There are 179 of them, 94 of which are crop maps; there is 1 table; there are 7 figures; there are 13 extra fine aero photos. The table shows solar and lunar calendar equivalents for the planting and harvesting date maps. There is a loose transparent sheet, showing the regions, which can be superimposed over the other maps giving data on soils, topography, temperature, and precipitation, population, crop areas, grave lands in cultivated fields, irrigated lands, flood and drought areas, forests, taxation, income, wages, labor units, cash crop, rent, ownership and tenancy, fertilizers used, animal units, human nutrition scales.

The statistical volume, at first scanning, seems a maze of detail. But read three more chapters of Dr. Buck's discussion and you are stacking volume III upon volume II and turning the pages to find among the 326 tables one headed something like this: *Use of Land and Water Area (estimates); or, Farm Wages (in silver yuan); or, Uses of Rooms in Buildings Used for Combined Residence and Farm Purposes on Small Farms*. And so it goes, all through this looking-behind-the-curtain of China's fine patchwork agriculture. Before you have gone much further into the study you will find yourself marveling at the tenacity of purpose of the Chinese farmer who works like the ant, passionately, who must know that his life-span is brief and hazardous—he shelters flimsily, guards his small stores only that he may eat scantily and die quickly to be buried in a grave in the very field that he has plowed.

The study had its inception 11 years ago at the second conference of the Institute of Pacific Relations at Honolulu. A year later, at the University of Nanking, a plan was drawn up and approved by the China Council and the International Research Committee of the Institute. Funds were secured and the mammoth undertaking was on its way under the guidance of economists, agriculturists, and foresters of the University of Nanking. Investigators were selected and trained, representative areas for each type of farming region were designated, and Chinese men went out to Chinese farms and villages where for 8 years they gathered detailed information relating to the underlying factors determining the trend of China's agricultural development and the welfare of four-fifths of China's teeming population—the farmers. These men visited 16,786 farms in 168 representative localities. They interviewed 38,256 farm families in 22 Provinces.

As planned by the economists at the University of Nanking the purpose of the project was threefold: "... first, to train students in the methods of research in land utilization; second, to make available knowledge of China's agriculture, for its improvement, and as a basis of national agricultural policies; and, third, to make available to people of other countries interested in China's welfare certain elementary information about land utilization, food, and population in China." No doubt most of the Chinese investigators, pushing into remote regions in quest of data, had little appreciation of the threefold purpose or of the scope of the project. They knew, however, that they were to select farms and families typical of the localities, and to ascertain and record the size of each farm and farm parcel, the cropping history of each small or large field, amounts of manures, oil cakes, and ashes used to fertilize the land, the number in the family counting all who dwelt under the roof from the head down to the brother's granddaughter, and the number of animals, usually living under the same roof as did the family—the food on the table at mealtime, the number of graves in a man's pastureland, the taxes a man paid, his income, his debts, or his savings.

By way of an introduction to the regional comparisons, Dr. Buck gives us a generalized chapter describing the peculiar characteristics of Chinese agriculture. Here he tells of the limiting factors as regards land use throughout the great area extending from Marco Polo's "ocean sea" almost to the Tibetan Mountains and from the boundary in the South to the Mongolian Desert. Rainfall and temperature, soils and vegetation variations, crop pests, erosion, racial group peculiarities and customs, transportation—all these are pointed out as the basic factors which account for the unique agricultural system employed by the millions of farmers in this Far Eastern country.

From the discussion of basic factors emerge some peculiar facts. For example, because of the inaccessibility of markets, opium as a cash crop has become adapted to mountain sides in the frontier Provinces—mountain sides which should be covered with forests. We learn too, that only 1.1 percent of all farm area is in pasture. This seems unbelievable until we realize that the four to six hundred million people who crowd the land are largely vegetarian, eating meat only on feast days, and that if an animal is to be found on the farm it is likely to be a water buffalo that pulls the plow or turns the water wheel and lives in the house with the family. We learn that a fourth of all cultivated land is terraced—stairstep hill and mountain sides, many badly eroded ones, where the people in their tenacious industry raise the food that keeps them alive for a time at least.

We learn that in China man has modified the land for farming purposes [probably to a greater extent than anywhere else in the world]. He has sliced the soil from the slopes and spread it in the valleys, for rice to feed the multitudes in the South; and in the far Northwest, in his extraordinary perseverance, he has gathered the pebbles from the streambeds and carried them to his field to mulch his soil. He has dyked and ditched for irrigation and to build lagoons for water chestnut and cress, and sometimes he has put down bamboo poles to draw out underground water. He does not know how to control the floods along his great rivers. We learn that almost all land in China is privately owned, that fragmentation of ownership is a serious economic handicap in many areas, that two-thirds of the land is twice-cropped each year, and that at harvest time there is a dearth of labor—woman labor, child labor, man labor. China's wheat harvest is about equal to that of the United States—it is practically all cut with sickles within a 2-week period.

We learn that farm production per capita is very low. The farms are so small and there are so many people. Weddings and funerals are costly. Farm wages are low, taxation of land is relatively high, most farmers are heavily in debt, the nutrition diet is insufficient, one-half of the farm people die before the age of 28. Overpopulation is serious, and this problem cannot be solved by migration and emigration. In Dr. Buck's opinion, the Chinese must work out a land-use policy under the present system of individual farm family agriculture. Can they do it? The answer to the question lies somewhere in the future, but should China emerge



BOOK REVIEWS AND ABSTRACTS

Continued



victoriously from the present war why should she not turn to this meticulous work, *Land Utilization in China*, with its wealth of data pointing directly to important needed policies and at least make the start?

The long chapter on agricultural regions which Dr. Buck has given us might constitute an exceedingly valuable volume in itself. The regionalization, based on physical factors and factors affecting type of land use and success and failure, is especially fortunate as it enables us to comprehend agricultural China as developed and persisted throughout milleniums, apart from wars, apart almost from trade, absorbing invasions and other interferences from outside.

For the purpose of the land-use comparisons, China is divided into two major regions, the wheat region and the rice region. Eight subregions are called "areas"—spring wheat, winter wheat-millet, winter wheat-kaoliang, Yangtze rice-wheat, rice-tea, Szechwan rice, double-cropping rice, southwestern rice. In the discussion of data many variations are brought to light, only a few of which can be pointed out here.

In the spring-wheat area, bordering that land to the far northwards, "where originally the Tartars dwelt," today Hans, Manchus, Mongolians, Turki, and Tibetans all swarm together to cultivate the depressions between sand dunes, the western hill and mountain slopes, and the plains which can be irrigated for wheat. According to the survey findings, here is a precarious agriculture, for the loess deposits erode easily and once the grasses are destroyed and the soils deficient in organic matter a wasteland desiccation creeps in. It is in this dry spring-wheat area that the people are seen carrying pebbles from the streambeds to their fields. Here fragmentation of land is universal, and one wonders how it will ever be possible to introduce true erosion control and to set up a land-utilization system to include dry-farming methods and an improved livestock industry to take the place of the land-destroying cultivation practices of the five peoples now occupying the area.

In the winter wheat-millet area, to the east and south of the spring-wheat area, and taking in the giant elbow of the Yellow River, they have a proverb which goes like this:

It is better to let your mother starve to death
Than to let your crop seed be eaten up.

This is the great loessial plateau of China, with soils of high natural fertility but now low in organic matter, where the millions of people live in cavelike homes carved out of the loess cliffs, practice an exhaust-the-land-and-move-on-to-new-land system of farming to produce their wheat and millet, and suffer periodic floods and famines. In this area erosion is so severe that fields must be irregular and very small because of the gullies, and areas are to be found where land rent is determined by the depth of the soil on the hills. It is not too difficult to imagine the farmer of Shansi or Fowping grimly standing guard over his millet seed while his mother starves or eats grass and bark to prolong a miserable existence.

The southern two-thirds of China comprises the great rice region and here is the land of vast networks of dykes, lakes, canals, rivers and flood plains which when coupled with a temperate or sub-tropical climate is especially adapted to rice culture. Here there are more people, the population increasing as we move southward until in the southwestern rice area there are 2,636 human beings to each square mile of crop area. It must have been exceedingly difficult to winnow the data from the surveys in this overpopulated land and form opinions and recommendations for land-utilization improvement. But Dr. Buck has pointed out major needs, area by area:

Flood control of the Yangtze and the Hwai in the Yangtze Rice-Wheat transitional area, with improved dyke construction and maintenance, and afforestation and pasturing of hill lands; for the rice-tea and the Szechwan rice areas he suggests that the development of communication and transportation is important and that much of the mountainous land should be in forest or special tree products; for the double-cropping rice area he points out the need for a study of the severely eroded mountainous areas to determine whether they should be forested or grassed, and drainage as a spe-

cial problem in the delta area; for the southwestern rice area he recommends "improved transportation to other parts of China . . ." so that ". . . the growing of the opium poppy could be more easily suppressed and the mountain sides could be devoted more readily to uses such as forests and special tree products."

Following his discussion of regional data, Dr. Buck presents chapters on the topography of China, the climate, the soils, "The Land" in which are some interesting features outside the survey data, land utilization practices entirely peculiar to China, crops grown and how utilized, livestock and fertility maintenance, size of farm, farm labor, prices and taxation, marketing as related to agriculture, population, nutrition, and standard of living. We are given an idea of the amazing altitudinal variations throughout China's agricultural areas, and from the climatic studies we acquire an understanding of China's famines as caused by droughts and floods. We read a detailed description of the soils and of erosion throughout the land, and an analysis of China's farm business from almost every conceivable angle. In the recommendations for China's "partial cure" we see some hope for China and a warning for the United States—that we may never know the day or the year or the century when we must include between the covers of an agricultural atlas a "record of famines" as caused by droughts and floods, by ruined soils, by overpopulation or by any other "modification of the land by man."

HIGHWAY STUDIES SERVE MANY USES

(Continued from p. 55)

Geodetic Survey, or on maps produced by other agencies. In several States, aerial photographs produced by the A. A. A. are being used both in making and checking the road inventory maps.

Such information as the volume and distribution of traffic on the highways, the extent of commercial movement of commodities and passengers, and other traffic data, concerns every bureau or commercial agency interested in marketing problems. In the collection of the data the States have been assisted by the Forest Service, the National Park Service, railroads, truck and bus operators, and other groups.

The relation of the highway planning surveys to the land use studies has already been discussed in the article "Roads to Market" (*SOIL CONSERVATION*, July).

Many other examples could be cited. Let it be sufficient to say that the data so far collected and analyzed in the highway planning surveys not only prove the value of the studies taken as highway planning exclusively, but also serve as a source for all kinds of economic planning, and therefore as a reservoir of information to be drawn upon by every bureau in the Department. The reservoir is being filled not only by the research activities of the State highway departments and the Bureau of Public Roads, but by the activities of many agencies within and outside the Department.



New Year Book.—The 1938 Yearbook of the Department of Agriculture, now in press, deals with soils. It is in five parts, with a summary by the editor. Part 1 pertains to public purposes in soil use and to problems, causes, and remedies. Part 2 discusses tillage, fertility, erosion control, irrigation, and drainage. Part 3 covers relationships between the soil and plants. Part 4 deals with fundamentals of soil science. Part 5 is a survey and description of the soils in this country, illustrated by a map. Information regarding availability of the yearbook will be given in a later issue of SOIL CONSERVATION.

New Publications that Many Conservationists Will Want

For **REFERENCE**
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

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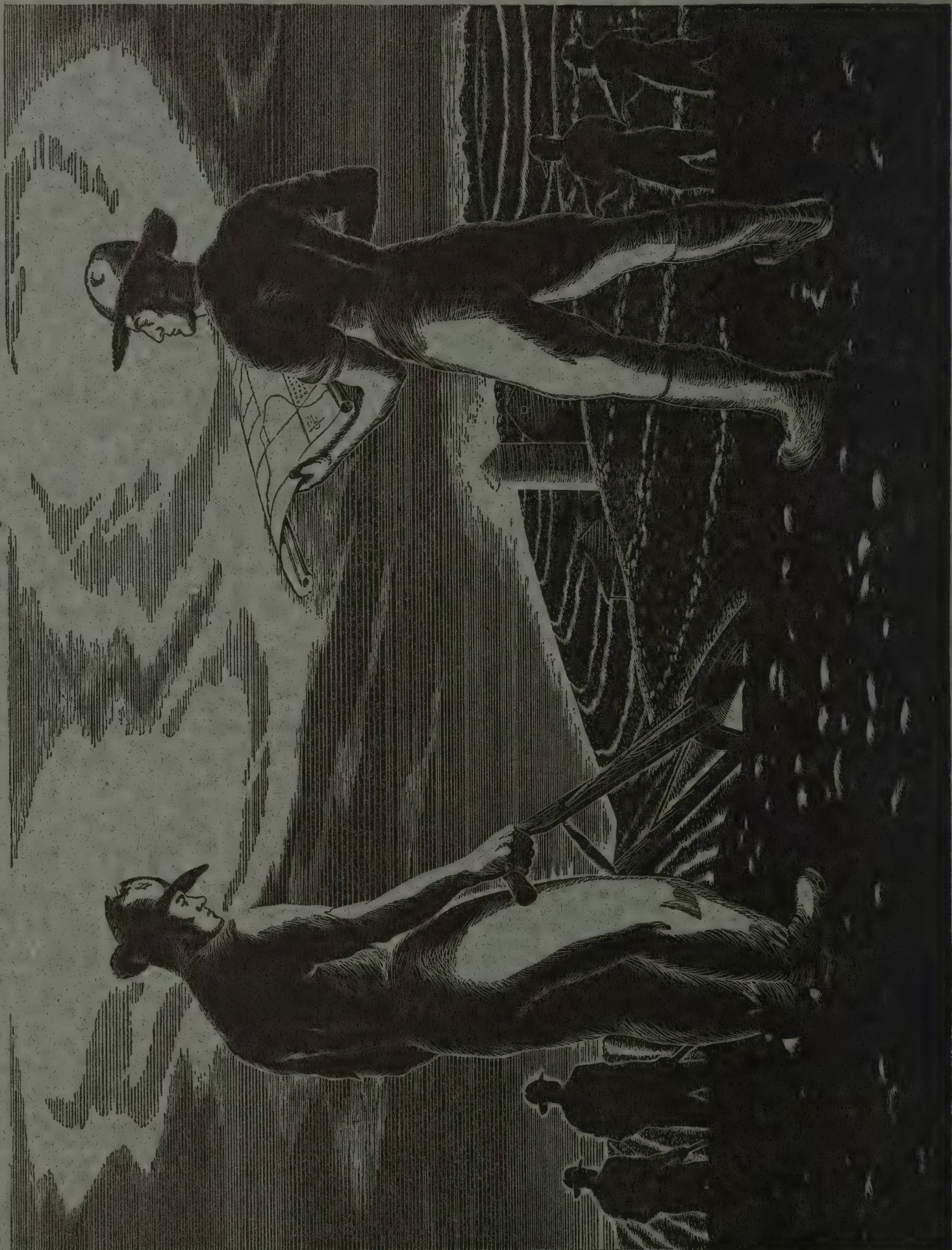
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¹ Mimeographed for use by technical workers in the U. S. Department of Agriculture and official cooperators only.

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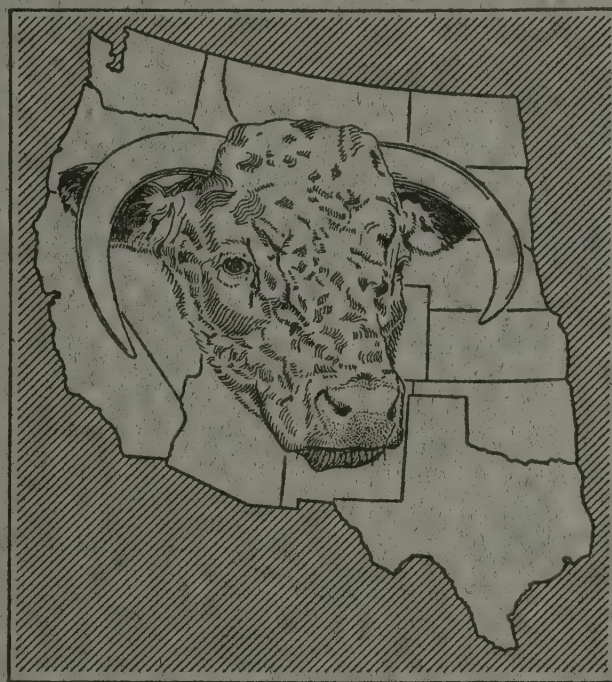
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SOIL CONSERVATION

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SEPTEMBER
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WELLINGTON BRINK
EDITOR

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Chief, Soil Conservation Service

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Livestock Industry Benefits From Range Management Program

By A. T. Semple¹

From the beginning of our work on public land projects in 1934, we have kept records showing changes in range land use for the improvement of perennial grass stands and to increase the cover needed on the land to reduce soil and water losses. On July 1, 1937 an additional set of records was instituted to collect data on soil conservation operations as affecting livestock numbers and their dependence upon pasturage. This recording system included operations on all private and public land projects of the Soil Conservation Service. Thus far, the data indicate a reduction in the number of livestock on range land in the western part of the United States. While as yet actual data showing the production of these reduced numbers are not available, there is ample information from field observations to indicate that cattle and sheep ranges stocked at carrying capacity produce more abundantly and more profitably than overstocked ranges.

AT THE end of March 1938, nearly 11 million acres on 59,216 farms had been brought under agreement on private land projects since the beginning of the work in 1934. The cooperative agreements provided for an 8.8-percent increase of the pasture acreage on these farms. On the 8,768 farms for which agreements were signed between July 1, 1937, and March 31, 1938, the pasture acreage was increased 21 percent. This indicates very creditable progress in our soil conservation program. Records on 310,578 acres of pasture brought under agreement during the above 9 months' period show that fully two-thirds of the acreage was overstocked. Accordingly, it is important that by means of pasture improvement the number of animal units provided for by the agreements is 10 percent greater than the number formerly kept on the farms. It is remarkable that the average period of grazing was increased from less than 6 months to more than 6 months. Undoubtedly, it is expected that pasture treatments such as fertilizing

and contour furrowing will add to productivity. During the 9 months' period, about 12 percent of the pasture acreage put under agreement was treated with contour furrows, ridges, and terraces. Over half was contour furrowed.

The 10 percent increase in the number of animal units provided for by plans for conservation operations on farms does not indicate necessarily an increase in the production of livestock and livestock products. In many cases, it means a better distribution of livestock which makes it possible for farm families to have such products as fresh milk and meat. Many of these families heretofore were without livestock or the means to such products.

On March 31, 1938, more than 20 million acres of range land were under agreement on private and public land projects, chiefly in the 11 western range States. For the past 9 months, on private range land brought under agreement, livestock was reduced 10 percent, while on public land projects the decrease was 27 percent.

(Continued on p. 71)

¹ Assistant head, section of agronomy and range management, Soil Conservation Service, Washington, D. C.

Range Conservation on Big Horn Draw

By Thomas E. Doughty¹
and Kenneth Fiero²



This rank stand of western wheatgrass, along one of the water-spreading structures in the Big Horn area, is typical of several hundred areas of this grass and blue grama, which resulted from approximately 50 stock-water and water-spreading dams constructed in the main and lateral drainages. Protection for natural reseeding was provided by controlled grazing.

THE results of range conservation on Big Horn Draw are typical of those to be expected over wide areas in the range country. Big Horn Draw is a segment of the Shoshone Indian Reservation on which a cooperative soil conservation project is being developed by the Soil Conservation Service and the Indian Service.

¹ Project manager, Soil Conservation Service, Lander, Wyo.

² Assistant range examiner, Soil Conservation Service, Lander, Wyo.

This range comprises a dry prong on the Little Wind River, 21 miles north of Lander, Wyo. The drainage is 15 miles long, drops 1,200 feet from source to mouth, has a wide alluvial valley flanked by steep, rocky slopes, and covers about 35,000 acres of typical Rocky Mountain foothill range land.

The area is an ancestral grazing ground of local Indians and has been used for years as a livestock trail between winter and summer range. In addition,

livestock owned by Indians and whites alike have had access to it on a year-long basis; consequently, the native vegetation became so closely shorn that it resembled scarcely at all its former climax condition. Grama, spiked wheat and slender wheatgrasses, needlegrass, nigger-wool, and sagebrush now are the main forage plants found on the slopes. On bottom lands, salt sage, brown sage, western wheatgrass, and small amounts of greasewood are the dominant plant species.

In 1935, one water hole at the junction of the Big Horn Draw and the Little Wind River, on the extreme southern portion of the range, provided the only permanent water available. Besides the permitted stock and the trail herds that loitered unnecessarily, a herd of 350 nondescript ponies were using the area. As a consequence of this indiscriminate grazing, a network of stock trails, cut deeper each year by hard trampling feet and running water, slashed the whole terrain adjacent to the water gap.

All types of erosion—wind, gully, and sheet—were present in a serious degree of advancement. Wind erosion was especially prevalent through the center where the soils vary from a clay to sandy texture. These soils had blown badly, with a removal in places of 12 inches and a resulting accumulation in hummocks often 20 inches high. Gullies, many of them 6 feet in depth, were especially prevalent in the draws of steep gradient with courses meandering down from the steep slopes on the north, east, and west sides into the center of the area. Deep steep-sided gullies, as much as 15 feet in depth, had also developed down the center of the draw from torrential rains. Sheet erosion was everywhere evident on all slopes regardless of soil texture, as there was little vegetation to decrease the erosive velocity of the waters. The main drainage extends up the area for about 9 or 10 miles where it branches into three smaller head drainways.

This range lies within a torrential rain belt where cloudbursts are recurrent during the summer months. Naturally, the denuded range lands offered an admirable medium for run-off and, according to engineers' estimates, 5,000 second-feet of water often escaped the draw during one downpour. This high intensity of rain, falling on the denuded gumbo soils ran off rapidly, collected into torrents, and rumbled down Big Horn Draw laden with silt, into the Little Wind River, a clear mountain stream.

In the fall of 1935, a joint soil conservation program was initiated between the Soil Conservation Service and the Indian Service for the correction of the mal-

practices destroying the range. The Soil Conservation Service made range and conservation surveys. A drift fence was constructed, thereby shifting the stock trail out of the denuded draw, and the Indian Service removed the surplus livestock from the area, allowing only permitted livestock to graze.

The conservation, engineering, and range surveys indicated that Nature would have to have assistance for rapid revegetation and to halt erosion. The main gullies were plugged with small dams and diversion ditches, made by a blade, which carried the water from the gullies on to the gentle alluvial bottoms where other spreading ditches kept the water deployed over the land and out of low places as far as possible.

Large stock-water dams were constructed approximately 3 miles apart to establish more or less permanent water. Insofar as possible, the stock-water dams were located adjacent to fertile alluvial valleys where spillway water is carried out and spread to increase native forage production.

The spreading system was laid out to simulate an automatic system of irrigation. A ditch, made by the grader pulled by a tractor, was run off on a slight gradient and finally leveled on a zero grade. The ditch was broken for several feet on the high places to assure effective spreading. When the water began to concentrate below, additional ditches were made to carry it away from depressions. The spreader ditches used on this range have an estimated water-holding capacity of 1 acre-foot for 43,560 linear feet of ditch. The purpose of the ditches is to hold part of the run-off and slow down and distribute the remainder of the water over a wide surface for maximum absorption.

In addition to the structural developments on this range, proper grazing management practices were likewise advocated. Trespass stock are kept from the area; sheep graze it during the winter, bed grounds being moved at least once every five nights while the old established bed grounds are avoided. A salting plan has been provided for both cattle and sheep. The salt is placed away from water holes and scattered out on strategic points. This is an aid to the proper distribution of cattle and horses.

The cooperative program of soil conservation has brought about a marked improvement on the range area in Big Horn Draw. While precipitation in 1937 was above average, the mechanical structures applied on the area held the complete rainfall so that none escaped into Little Wind River.

In 2 years, the native vegetation has made a remarkable recovery. The following information offers some typical results of the soil conservation practices:



Looking south on Big Horn Draw. In the foreground, a large stock-watering dam and a water-spreading system; in background, typical range land.

After one season of water-spreading, blue grama was clipped, on October 15, 1936, from plots 100 square feet in area, and its yield was compared to similar clippings of blue grama on untreated areas, neither subjected to grazing. Two and eight-tenths (2.8) as much blue grama was produced on the treated area as on the untreated area. This is significant in that the grama composed 96 percent and 89 percent of the total vegetation present respectively.

The following spring (June 21, 1937) similar clippings were made to determine the effect of increased plant vigor, resulting from the water-spreading of the previous year, on the abundance of early spring growth. The amount of forage produced immediately below the water-spreading structures was two and one-tenth (2.1) times as great as it was above. The differences on the treated area are probably due to the impounding effect of the spreader ditch which allowed the vegetation below the structure to receive both surface and underground water.

The percentage of moisture above and below the spreader structure in the first 2 inches of soil was found to be 6.78 percent and 10.85 percent, respectively. In the 2- to 6-inch depth it was approximately the same, being 19.56 percent and 19.86 percent, respectively. In the 12- to 16-inch depth the percent of moisture was 7.09 percent and 9.15 percent, respectively, or 23 percent higher below the spreader ditch. These figures seem to bear out the statement above,

accounting for the increased yield below the spreader ditch.

The cost of constructing these spreader ditches, with a 22-horsepower gas caterpillar tractor and terracer, was \$15.20 per mile; with a 60 hp. Diesel caterpillar tractor and blade, the cost was \$3.91 per mile.

More About Crop Rotation

Recent observations at Garland, in the Black Belt of Texas, brought out several interesting points regarding the possible effect of crop rotation on cotton root rot. Cotton grown in strips which had been in small grain for one year showed much less infestation by cotton root rot than that grown in adjoining strips which had been continuously in cotton. It is known that the grass family, which includes small grains, is immune to cotton root rot.

Little bluestem has been successfully established at Garland by planting the seed with an ordinary cotton planter set wide open. Seedlings made last spring were producing seed in the fall. Ryegrass is making a wonderful showing at Garland and some farmers have had excellent returns from seed production.

These facts show the opportunities offered by diversification in farming practices in the Black Belt. Not only has infestation by cotton root rot been diminished, but sources of income other than cotton production have been initiated and, by contour strip cropping and the use of close growing vegetation in rotation, erosion control has been effected.—C. R. Enlow.

Corrugation Furrows in the Smoky Hill River Project

DROUGHT, overgrazing and wind and water erosion have severely depleted native grass pastures in the vicinity of the Smoky Hill River project of the Soil Conservation Service, located at Cheyenne Wells, Colo.

Buffalo, grama and other native grasses, which according to the old-time residents once covered the range with a solid protective sod, have been destroyed to a point where much of the ground is bare and subject to intense wind and water erosion. A wide variety of weeds and annual grasses of little erosion resistance or value as livestock forage has replaced the native grass cover in many places.

Dust storms of recent years have covered these native grass pastures with a fine colloidal silt deposit of varying depths which is almost impervious to moisture penetration. This condition, combined with the sparse vegetative cover, has greatly accelerated the run-off from the subnormal rains of recent years. As a result, only a small amount of moisture has been taken into the soil where it could be utilized by the grass roots. Rainfall run-off tests on average slopes and soils at Cheyenne Wells show an average of approximately 70 percent from a 2-inch rain.

Approximately 40,000 acres of pasture land in the Smoky Hill River project area have been contour furrowed during the last 2½ years. Water conservation structures of a wide variety have been built, depending upon the soil types, slopes, equipment, and labor available. Farmers and ranchers have observed that any type of contour furrow or ridge that will prevent run-off is of great value in the control of water erosion and the stimulation of vegetative growth.

Technicians of the Cheyenne Wells project have developed a unique type of contour furrow which for want of a more appropriate name is being called "corrugation." This type of furrowing has been done on approximately 10,000 acres of grassland in the area during the last year. Visitors from adjoining counties and States have viewed this work, and now similar furrows are being constructed in many different localities.

Corrugation furrows at Cheyenne Wells are being constructed with an 8-foot road grader or terracer. The cutting blade of the machine is removed and three shovels, each 5 inches wide and 5 inches deep,



Terracing-machine blade, as equipped for corrugation work on the Smoky Hill River project. Shovels are fastened to the blade, and extensions to the blade are provided for a better spreading of the disturbed soil.

By W. R. Watson¹

are bolted to the blade proper, one shovel at each end of the blade and one in the center. Three furrows, each 5 inches wide and 5 inches deep, are made at one time. Extensions made of boiler plate, 2 feet in length, are fastened to each end of the blade beyond the outside shovels. The furrowing machine is pulled by an ordinary farm tractor.

In operation, the blade is set so that it clears the surface of the ground by about an inch. Dirt thrown out by the shovels is distributed evenly between the furrows by the blade and extensions. Only 15 inches out of a possible 96 inches of sod are disturbed and none of the sod is covered to the extent that the grass cannot come through.

Persons who have observed this type of furrowing believe that the mulching of the spaces between the furrows by the topsoil from the furrows is beneficial to vegetative growth.

The furrows can be made with numerous adaptations of the terracer or grader. A lister with the moldboards clipped and a drag attached will construct a similar furrow. Most any farmyard will provide sufficient material to build a furrowing machine of this type.

¹ Associate range examiner, Agronomy and range management section, Soil Conservation Service, Amarillo, Tex.



New "corrugated" furrows on which no rain had fallen. Note how soil from furrows spreads evenly over area, not too deep for the grass to come through.

Furrows of this type are not being constructed on sandy or highly dispersible shale soils as it is felt that they would be too short-lived to be effective. Such furrows on heavier soils have shown little silting at the end of the first season—except where uncontrolled run-off from adjoining pastures or blow dirt from adjacent cultivated fields were hazards.



These furrows, constructed in August 1937, had received about an inch of rain. There is no trace of the upturned soil. The Buffalo and gramas are making a nice showing.

On slopes of 2 percent or less, corrugation furrows usually are constructed on half of the land in alternate strips. On steeper slopes, the pastures are furrowed solid at 4-foot intervals. Where the slopes are steep and the topography rolling with definite drainageways already formed, the furrows are used in conjunction with diversion structures. These structures take the excess water from the drainageway and divert it to adjacent pasture where it is spread evenly by the corrugations.

The value of corrugation furrows may best be illustrated by specific figures. Assuming that the furrows were spaced 4 feet apart and were of some nonporous material, it is found that one acre of land so treated would have a storage capacity in the furrows of 44,119 gallons of water. This storage capacity would be equal to the precipitation from a 0.51-inch rain without figuring any penetration between the furrows or allowing for any run-off.

A 2.25-inch rainfall early in the summer of 1937, just after the furrows were constructed, showed no

appreciable run-off. This proved that the furrowing not only had stored a considerable amount of water, but also had improved the condition of the soil for absorbing moisture.

In order actually to compare vegetative results from this type of furrow with unfurrowed land, several tests have been conducted by technicians of the Smoky Hill River project at Cheyenne Wells.

A series of 10 plots, each one meter square, was laid out at 10-foot intervals in a pasture that had been furrowed at intervals of 4 feet. A similar group of 10 plots was laid out on an untreated pasture less than a hundred yards away. Soil types and slopes are the same. Vegetative density on both groups of plots was the same when the furrowing was done in April 1937.

At the end of the 1937 growing season when all vegetation was thoroughly cured, grass and weeds on all the plots were carefully clipped and weighed. The 10 plots on the furrowed area produced an average of 47.85 grams of air-dry grasses to the square meter. Plots on the untreated area produced an average of only 23.93 grams to the meter. Converted into pounds, the furrowed pasture produced 425.9 pounds of air-dry grass to the acre while the untreated pasture produced only 212.9 pounds. This air-dry grass was valued at \$6 a ton. Based upon this valuation, production on the furrowed land was \$1.27 an acre as compared with only 63 cents on the untreated pasture.

Cost of constructing corrugation furrows is 46 cents an acre for solid furrowing, and 26 cents an acre for treating half of the pasture in alternate strips. These costs include all charges for surveying, labor and equipment.



Grass growth on a pasture in the Cheyenne Wells project "corrugated" in April 1938. By actual weight tests, this pasture produced 435.9 pounds of air-dry grass per acre, as compared with a production of but 212.9 on nearby untreated land.

Technicians of the Soil Conservation Service point out that this type of furrow can be made by most farmers or ranchers without any investment in extra equipment, and that it is a job which can be done during the slack season.

Grazing Program in the Dry Land Section of Eastern Oregon

By E. William Anderson¹

THE 2,860-acre ranch of an early pioneer near Heppner, Oreg., is typical of the medium-sized livestock ranch in the eastern Oregon dry land section in which the Soil Conservation Service is instigating range-conservation plans.

Area under-utilized, due to lack of water. "A" condition range with perennial bunchgrasses predominating.



The ranch is used for spring, summer, and fall grazing for about 160 beef cattle and 15 horses. During the late fall and early spring the livestock are grazed on an allotment in the No. 7 Oregon grazing district, and during the winter months on another ranch owned by the cooperator. All but 208 acres (cultivated) of the ranch is native bunchgrass range with bluebunch wheatgrass (*Agropyron spicatum*), Sandberg bluegrass (*Poa secunda*), and bluebunch fescue (*Festuca idahoensis*), constituting the major part of the vegetal cover.

A forage inventory was made of this ranch, with the square foot density method, to determine the range condition and serve as a basis for recommendations. A grazing plan was drawn up for the entire ranch. The plan consisted of the recommended dates of use for each unit, carrying capacity, and the class of stock to graze the area.

From an analysis of the range survey data the following conditions were found to exist: The range as a whole is in good condition. The A and B condi-

tions (see accompanying map) show no sheet erosion to slight sheet erosion. The C and D conditions show moderate to severe sheet erosion with small gullies forming on the steeper slopes. The main drainages are all marked by gullies, some of which are partly

stabilized by vegetation and others active to a severe degree.

The results of the range survey show that the past rate of stocking has not been in excess of the estimated carrying capacity. Due to lack of proper distribution of water over the ranch, however, some areas have received forced overgrazing while other areas remained under-utilized. The overgrazing has occurred in the immediate vicinities of several waterholes or on areas accessible from the waterholes. The result has been an increase of annual grasses and weeds with a decided reduction of carrying capacity and erosion-resisting cover.

With the major problem one of correct stock management, range conservation practices were incorporated into the ranch plan to obtain the desired stock distribution and to correct over-utilization of some areas. This may be noted on the map.

Four springs, evenly distributed over the ranch were developed to provide at least one spring to each section of land (640 acres). In this development the

Overgrazed area in vicinity of the waterhole. "D" condition range, with annual grasses and weeds predominating.



¹ Assistant project range examiner, Soil Conservation Service, Condon, Oreg.

springs were dug out and concrete cut-off walls and catchment basins were installed. Troughs were constructed from logs, and water was piped from the spring to the troughs. One to several troughs were placed at each spring so that water is now available throughout the dry summer and fall season. With the development of these springs, it is possible to graze the entire ranch under a system of deferred and rotation grazing by the proper number of stock and during the proper seasons.

To obtain more even distribution of grazing within the unit, salt ground sites were selected and coordinated with the spring developments in each grazing unit. These sites are all located on the ridge-tops away from the springs and will help in eliminating a concentration of grazing around the springs and in the adjacent canyon bottom. Sufficient sites were selected in each grazing unit so that the aggregate grazing between and around the spring and salt grounds would thoroughly cover the unit.

Salt is provided at the rate of 2 pounds per head per month, and the number of pounds to be put in each grazing unit is computed by the number of animal months of use which the unit will receive, as outlined in the grazing plan.

The system of rotating the use of the salt grounds is such that the salt will be changed from one salt ground to another as soon as the range in the immediate vicinity is utilized to the desired intensity. By this method of rotation it is possible to give added protection to the overgrazed areas of each unit.

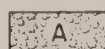
In this dry land area where native range is used for spring and summer grazing, it is very important that no grazing be allowed until the range growth is 6 to 8 inches high. It is also very important that the perennial grasses be allowed to mature seed for natural revegetation at least once every 4 years.

In order to make possible the deferred system of grazing, and to simplify the management of the stock for more even grazing distribution, it was necessary to divide a large area into two separate grazing units by construction of a three-wire cross fence; thus three major range units were formed for the deferred and rotation system of grazing. The location of this fence was selected so that the carrying capacities of the resulting two units would be quite similar, simplifying management of the stock by having equal periods of use.

In one place it was necessary to construct approxi-

(Continued on p. 83)

VEGETATIVE CONDITION



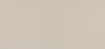
A Climax vegetation present and forming the bulk of the cover, little or no invasion of plant species outside of the climax stage of succession.



B Climax vegetation in abundance, but area sparsely invaded by perennials and annuals lower in the scale of plant succession.



C Climax vegetation present but not in abundance. Rather heavy invasion of perennial and annual forbs and grasses.



D Climax vegetation absent or nearly so. Vegetation mostly of unpalatable perennials and annuals.

L Cultivated lands.

GRAZING PLAN

UNIT 1 187 Acres—97 Animal Months
1938—3/15—5/15 10 horses
5/15—7/15 15 horses
7/15—8/15 10 horses
1939—9/10—10/15 60 cattle

UNIT 3 66 Acres—Not Established
1938—Protected
1939—8/15—9/10 60 cattle
Based on Potential C.C.

UNIT 2 956 Acres—464 Animal Months
1938—3/15—8/15 88 cattle
1939—1/1—3/15 10 horses
8/15—10/15 15 horses
10/15—12/31 151 C & H

UNIT 4 900 Acres—437 Animal Months
1938—8/15—10/15 15 horses
10/15—12/31 136 cattle
1939—3/15—8/15 10 horses
60 cattle

UNIT 5 489 Acres—222 Animal Months
1938—1/1—3/15 10 horses
8/15—10/15 60 cattle
10/15—12/31 15 horses
1939—10/15—12/31 28 cattle



LEGEND

Fence ——— Fence Construction
Creek ——— Relocated Fence
Salt Ground ⊖ Spring Development

1/2 0 1
SCALE IN MILES

SOIL CONSERVATION PRACTICES ON RANGE AND PASTURE LANDS SHOW INCREASED RANCH INCOME

BY AVERIL B. NIELSON¹

RANGE conservation measures which have been applied in project and camp areas in eastern Washington and northeastern Oregon are now showing increased profits to livestock operators. The 1,322-acre livestock-wheat ranch of a pioneer settler at Pomeroy in Garfield County, Wash., is here described as an example of typical results obtained through the establishment of a sound, long-time agricultural program.

The land over much of this territory was originally used for grazing livestock. Settlers arrived in the early seventies, the bunchgrass sod on the bottomlands was broken and crops of spring wheat were grown. Shortly after the turn of the century a change was made to a winter-wheat and summer-fallow system. Cultivation was extended to many of the steeper slopes and the hilltops. It did not extend, however, to the more precipitous and inaccessible areas along canyon breaks, as may be seen by the extensive virgin grasslands which remain today in these locations.

Soils of the area, prairie silt loams, are highly erodible whether they are overgrazed grasslands or cultivated lands, and tend to wash and gully rapidly following depletion of their organic matter. Accelerated erosion under these conditions is a serious problem on both depleted range land and cultivated lands. Drainage-ways are marked by deep gullies. Rock-strewn "scablands" remain here and there as mute evidence of extensive soil losses.

Excellent stands of native bunch wheatgrass (*Agropyron spicatum*), blue bunchgrass (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), and balsam root (*Balsamorhiza sagittata*) dominate where grazing has been properly managed or restricted by natural barriers. Brushy areas are, as a rule, confined to the higher elevations and north slopes. Annual grasses and weeds predominate in areas subject to heavy and continued grazing.

Ranges on the north and east slopes enjoy the best growing conditions; they are subjected to a shorter grazing period, and run-off is slower. Early spring grazing on sunny south and east slopes damages them.

Unregulated grazing on range lands, coupled with a wheat and summer-fallow cropping system, were the land-use factors under consideration on the cooperator's ranch.

Moderate to severe sheet erosion obtained over the entire grazing area. Very active sheet and gully erosion was in evidence on wheat lands. The vegetal cover was in process of rapid regression from perennial grasses to annual grasses, weeds, and forbs. The carrying capacity of these grasslands was about one-fourth of its original carrying capacity.

No attempt had been made to secure distribution of the livestock by supplying adequate water, salt, and division fencing.

A detailed conservation survey map is presented with this article, showing erosion, land use, slope, and soil types. The planning of this range was based upon a range and economic survey and a study of this map in connection with the land-use and grazing schedule map gives an idea of the problem and the measures initiated to control erosion. The new system was immediately more profitable to this rancher than was his old method of grazing which was fast depleting his pasture and range resources and was setting up critical erosion conditions.

When work was begun the cooperator accepted a complete 5-year soil-improving crop rotation of sweet-clover and grass on all the cropland except the areas retired from cultivation and seeded permanently to alfalfa and grass. He also agreed to strip crop, till, and harvest on the contour, and to utilize properly all crop residue. Definite systems for rotational grazing were planned: Unit 1 for the beef cattle; unit 2 for the dairy cows and horses; and unit 3 for the sheep.

The land-use map shown gives the grazing schedule for three units, beef cattle, sheep, and dairy cattle, as planned for this ranch. Under the system adopted the erosion potential will be practically overcome within 3 to 5 years and eventually the rancher's income will be augmented.

The cooperator owns and operates 1,322 acres, of which 373 acres are cultivated and 940 acres are native grass range. He owns 6 horses, 65 cattle (not including calves), 43 sheep, and 30 hogs and pigs. The stock is fed approximately 85 tons of alfalfa, sweet-

¹ Project range examiner, Soil Conservation Service, Dayton, Wash.

clover, and grain hay, and 683 bushels of barley and wheat during the winter from December 1 until April 15; the dairy cows and pigs are fed throughout longer periods.

In order to provide for a deferred rotation system of grazing on this farm it was necessary to build 450 rods of fence, to develop four springs and to recommend salt site distribution at locations distant from the water and from over-utilized areas. The number of livestock and the periods of grazing were planned according to the estimated carrying capacity for all units of the pastures.

The sweetclover and grass seedings serve as supplemental pasture during the fall on first-year seedings and during the spring on second-year seedings before they are plowed under as a green manure crop.

1938 Grazing Schedule UNIT NO. I. BEEF CATTLE UNIT

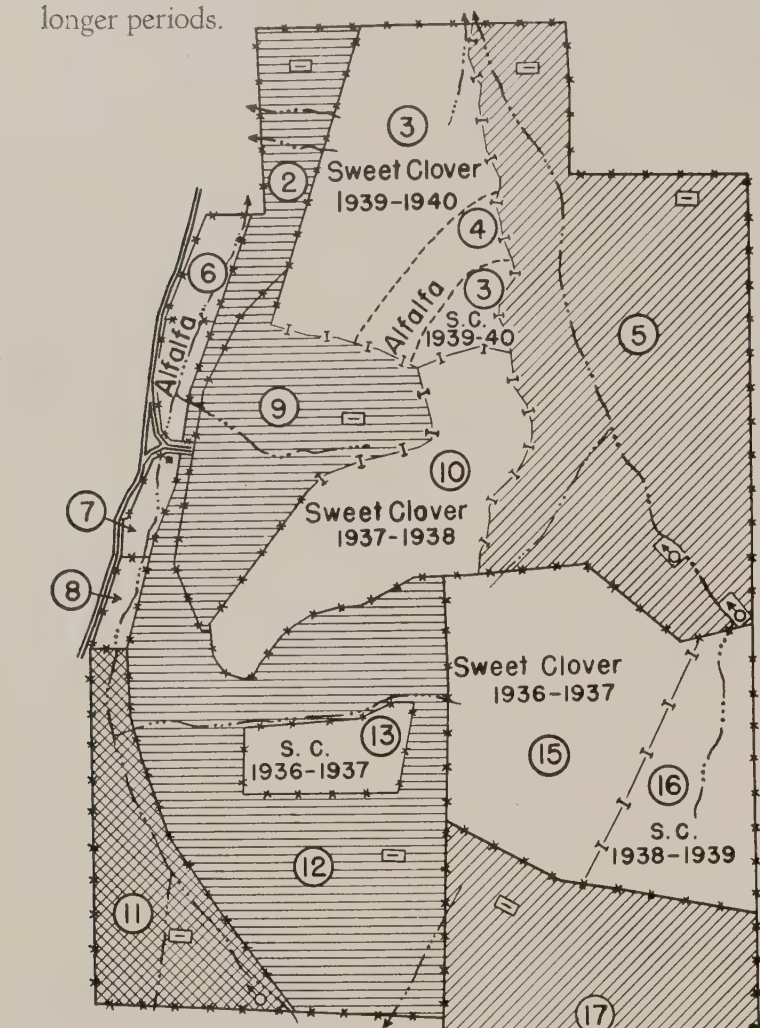
Dates of use				Field Nos.	Acres	Forage type	Carrying capacity, animal months	
Month	Day	Month	Day				Animal units	
							Actual	Estimated
4	1	5	2	19 and 21	115	Range.....	46	49
5	2	6	10	10	46	Sweet clover and grass 2 years.	46	57
6	10	7	10	5	173	Range.....	40	40
7	10	8	1	18	79	do.....	40	26
8	1	8	15	16	39	Sweet clover and grass 1 year.	40	20
8	15	9	1	23	45	Range.....	40	20
9	1	10	1	17	128	do.....	40	40
10	1	11	1	5	173	do.....	40	40
11	1	4	1	Feed Lot				

UNIT NO. II. DAIRY CATTLE AND HORSE UNIT

4	1	5	15	9	68	Range.....	19	26	26
5	15	8	1	6	13	Alfalfa.....	19	39	39
8	1	11	1	12	143	Range.....	19	39	44
11	1	4	1	2	31	do.....	Deferred		
				Feed lot					

UNIT NO. III. SHEEP UNIT

4	1	5	1	7 and 8	9	Grass pasture.....	9	9	9
5	1	10	1	11	51	Range.....	9	45	45
10	1	11	1	3	49	Alfalfa stubble.....	9	9	9
11	1	4	1	4	12				
				Feed lot					



LEGEND

- Graded Road
- Old Fence Line
- - - New Fence Line
- ~ Intermittent Stream
- Spring
- ◻ Developed Spring
- Dwelling
- ◻ Salt Ground
- ▨ Unit I
Beef Cattle Unit
- ▨ Unit II
Dairy Cattle & Horse Unit
- ▨ Unit III
Sheep Unit

500 0 1000 2000 3000
SCALE IN FEET

LAND USE AND GRAZING SCHEDULE MAP

Approximately the same acreage of sweetclover is seeded out each year to ensure sufficient forage, to relieve the range, and to allow rebuilding of the wheat lands by systematic rotation. Excess sweetclover may be clipped and used for hay. The permanent alfalfa and grass seedings produce high quality hay for winter feed, and the crop aftermath is pastured lightly in the fall along with adjoining wheat fields.

Under proper management the range pastures have increased in forage density from 42 to 63 percent in 2 years and the carrying capacity shows an increase of approximately 112 percent. The cattle are in better condition in the fall and are more contented on the range than they were under the old operation. The yearlings show more rapid and economical gains; in 1937 and 1938 they were sold as grass-fat baby beef, off the sweetclover and grass, at top prices.

On the 2d of June the cooperator was interviewed at his farm. A few of his statements regarding the new grazing program will help to show the importance of this cooperative work now being carried out between the Service and farmers and ranchers:

"I had known that my range pastures were not being grazed evenly and that most of them were overgrazed. Now nothing could convince me that the old management was better than the new. The number of livestock on my farm is about the same as it formerly was; I sold some of my horses and bought a tractor, and the dairy cattle and sheep herds have been increased. Through the deferred and rotational grazing, and relief from grazing by means of the sweetclover and grass seedings, feed production is greater on my range land, and all the native pastures on my farm have improved especially in the density and height of the bunchgrass. There is less cheatgrass and weeds. The 450 rods of fence which the Soil Conservation Service helped me to build has made it possible for me to protect my rotational and permanent seedings and to divide my pastures for proper management.

"The four springs which have been developed on my farm, together with the salt distribution system, allow the stock to eat the grass evenly over all the pastures. The sweetclover and grass seedings pastured in the spring are a great help in protecting the young grass on the range. Some people claim that their cattle will not eat sweetclover and get fat on it, but our cattle show gain from sweetclover and they like it. I have no trouble from bloat. Throughout the past 2 years, instead of fattening my beef in the feeding lot, I have pastured them on my sweetclover and sold them as grass-fat beef at top prices.

"My sheep did better last winter on alfalfa hay from my permanent seedings than they ever did on grain hay. Small areas that do not fit well with general cropping practices can be seeded to alfalfa and grass for hay and pasture, and they bring profitable returns. Gullies that formerly were uncrossable are now controlled and seeded to alfalfa and grass. They can be crossed anywhere, and the alfalfa is used for hay for my stock."

LIVESTOCK INDUSTRY BENEFITS

(Continued from p. 61)

On badly depleted ranges where most of the desirable perennial grasses have been killed out and stock are depending principally upon annual weeds, such sharp reductions in stocking are necessary in order that the grasses may have a chance to restore their vigor and increase their stand. Without protection from grazing, especially during the growing season, the grasses do not have this chance—they are more palatable than the weeds and are eaten down to the ground as fast as they grow.

There has been a strong feeling among some of the leaders in livestock affairs that increases in pasture acreage resulting from the retirement of cultivated cropland to pasture would cause an increase in the production of livestock and livestock products. This feeling became strongly evident when the original crop-control legislation was put into effect in 1933. It has persisted to a limited extent among dairymen and western stock and wool growers in spite of the fact that approximately 70 percent of the acreage of all crops is used for livestock feed; and that corn, the principal cultivated crop, produces considerably more feed than the same land would produce in grass; that about half of the wheat and cotton crops are used for livestock feed, as bran, cottonseed meal, etc.; and that there has been a marked increase in livestock production concurrent with an increase in crop acreage and a decrease in both pasture acreage and pasture productivity.

A very thorough study relating to this subject is reported in Iowa Bulletin 361, December 1937. The title is "Livestock Production in Iowa as Related to Hay and Pasture Acreage," and the author is Walter W. Wilcox. The following extracts from the text and summary of this bulletin are particularly significant:

"Dairying has been increasing rapidly in Iowa during the past decade in the face of a decrease in hay and pasture acreage. Apparently price relation"

(Continued on p. 74)

Thirteen Years of Contour Furrows

By D. V. Shuhart¹

IT was interesting to find in the semiarid climate of Stillwater Creek an acreage of contour furrows which were 8 years old when the Soil Erosion Service started the project in 1933. Contour furrows had been plowed along lines run by an engineer; the furrow slices were turned downhill; gullies had been skipped; furrows were spaced approximately 10 feet apart—these furrows had been plowed for water conservation.

The city of Stillwater, Okla., built Boomer Lake Dam in 1925 for a municipal water supply. The Carter C. Hanner Post of the American Legion, being civic-minded, appointed a committee to work out the details for planting trees on a part of the badly eroded and overgrazed pasture which bordered the west shore of the lake.

It was recognized that the eroded Vernon clay loam was a very difficult site on which to establish trees,

type of labor available. Business men not accustomed to such work might tire after the first 10 or 12 water pockets were constructed. It was thus that the idea of contour furrows for moisture conservation was conceived—as a result of consideration for the tender hands and the soft muscles of business men who were to plant the trees.

Prof. R. E. Kirkham, a civil engineer, was asked to volunteer his services to run the lines. Laths were used to stake the lines, which were plowed about 6 inches deep with a 12-inch walking plow. Trees were planted in the furrows which waited to catch and hold the raindrops. Needless to say, the area was protected from grazing.

Are these the oldest contour furrows plowed along surveyed lines in grassland with the idea of moisture conservation definitely in mind? I venture to say that possibly they are. One familiar with southwestern Texas is of the opinion that the increased grass growth noticed on contour furrows at Abilene, in 1899, was in reality an observation of increased growth on furrows plowed for the protection of ranges from fires, a common practice in that area.

Rain did not come in time. Continued drought killed the trees in the summer. The scars left by the

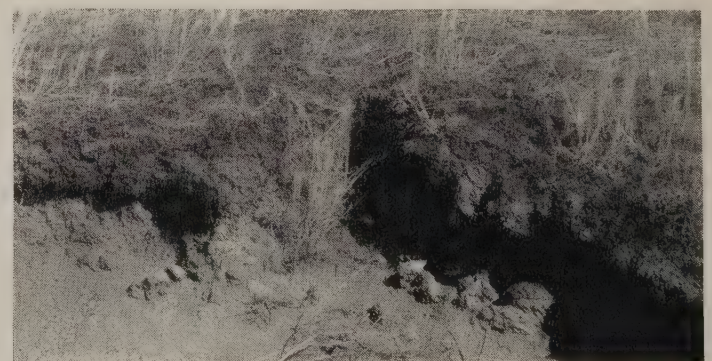


Thirteen-year-old contour furrows surveyed and plowed for water conservation in an unsuccessful tree-planting project on grassland.

especially the bare-rooted 6- to 8-inch Austrian pines which were selected for their availability rather than their adaptability to the site. The trees were obtained from the State forest nursery, and plans were made to use the voluntary labor of public-spirited citizens in planting them. The original scheme was to construct water pockets by slicing off the competing weeds and grass from a 2-foot circle, then leveling off the spot and using this material for a semicircular dam on the downhill side. Some people had observed that during dry years cotton plants in small depressions grew much larger than other plants in the same field—hence the idea for the water pockets.

But the plan presented difficulties because of the

Close-up of head erosion from a 13-year-old contour furrow. Maintenance or furrow-blocking could have prevented this damage.



¹ Section of information, Soil Conservation Service, Salina, Kans.

contour furrows were soon covered with sufficient weeds and grass to hide them. Some burning occurred during the years that followed, but by 1933 the vegetative cover was so dense that the eye of the camera failed to reveal the contour furrows when the aerial photographs of the Stillwater Creek watershed were made.

An unsuccessful attempt to plant this area to pine trees was made again in 1934, but the contour furrows were not observed because of the dense growth of grass. A technician making a soil and erosion map in 1935 failed to notice their presence. They were indeed hidden in vegetation. There they remained without maintenance, for 13 years. They now offer an interesting study in ecology.

Many questions have arisen from time to time concerning contour furrows. Here are four of them: Will the increased water supply in the disturbed furrow cause a succession of forbs? Will water concentrated by furrows, due to slight irregularities in



Washout caused by concentration of water from 13-year-old contour furrows on which no maintenance has been applied.

the contour, cause the formation of gullies? Has contour furrowing improved the cover on areas which were sheet-eroded almost to the C horizon? How does the cover of vegetation on contour-furrowed land compare with that of adjacent soil and slope on which elimination of grazing alone has been practiced? These questions all involve some element of time. Some of them have been answered from a common-sense background, others from results secured over a short period of time.

A critical study of this field which has been contour furrowed for 13 years reveals some interesting points which may contribute something to the answers of these questions.

The removal of grass whether by overgrazing, drought, or by plowing, is quite definitely associated with the succession of weed stages. Contour furrows and contour ridges do permit weeds to grow readily on the disturbed areas, especially when stimulated by increased moisture. It is encouraging to note that



Little bluestem (*Andropogon scoparius*) is dominant on this part of the 13-year-old contour-furrowed area, although no mowing has been practiced.

newly developed furrowing machines attempt to reduce the disturbance of grass to a minimum.² After 13 years of forb and grass competition on the contour-furrowed field, without the aid of mowing, little bluestem (*Andropogon scoparius*) is decidedly dominant in one portion of the field; Indian grass (*Sorghastrum nutans*) is dominant in a second portion; bluegrama (*Bouteloua gracilis*) is dominant in another portion. Fall witchgrass (*Leptoloma cognatum*) is dominant in another, and triple awn grass (*Aristida oligantha*) in still another. Many forbs are present but in no place are they dominant although in certain seasons they may appear to be so because of their conspicuous foliage.



Moss binding the last remnant of soil above the C horizon at the edge of a washout.

One of the greatest hazards of contour farming, level terracing, contour ridging and furrowing is the possible damage from slight inaccuracies in contour lines—these inaccuracies cause water concentration. Concentrated water, put in motion by breaks at points where vegetation is sparse, will form gullies. At one point in this field the contour furrows crossed a slight depression which was easily skipped by the instrument when the lines were run. The soil at this point was shallow and the cover of vegetation was

² Bloom, Merle W.: Contour Furrows Constructed Without Loss of Sod. SOIL CONSERVATION, October 1937, p. 105.

barely sufficient to check normal sheet erosion. Water concentrating in the furrows overtopped them and a gully was started. Each furrow contributing water to this spot developed an overfall at its mouth. Curiously enough, the furrows below this area caught and held all material washed from above and the lower end of the eroded spot has become completely grassed over. The soil along the edges of this area is being protected from more rapid erosion by a moss which covers it from the A to the C horizon. Head erosion in each furrow has widened the gully with the result that it now presents the appearance of a typical alkali spot. This damage could have been avoided by maintenance or by the use of small dams across the furrows.

The importance of these small dams cannot be over-emphasized. Damming attachments on listers and more recently on furrowing machines³ indicate that some attention is being given to this most important consideration, but it is still too common that one may sight along the top of a contour furrow without dams and observe ups and downs which water in seeking its level cannot follow.

A part of the field was sheet-eroded almost to the C horizon when the contour furrows were constructed. Some scattered triple awn grass was on this area at that time. Now, after 13 years, triple awn grass is still present. In one place in this area, it has formed a dense cover and is decidedly dominant. A few scattered clumps of silver beardgrass (*Andropogon saccharoides*) and fall witchgrass are found among the triple awn. The contour furrows can be traced by the Indian grass growing in them. In the other part of this area triple awn grass has been practically replaced by fall witchgrass which, being perennial, may prove to be an important intermediate stage in the succession from triple awn grass to the short grasses. In this second portion, however, little bluestem occurs in or near many of the furrows, indicating that this grass rather than the short grasses may follow fall witchgrass.

Belt transects and quadrat studies have been planned but have not progressed far enough to answer definitely our final query. Preliminary observations indicate, however, that the cover of vegetation developed by each major species on the contoured area is decidedly greater than that developed on an adjoining area of like slope, soil, and history. Little bluestem is denser on the contour-furrowed part of the field than in any comparable area in the field. Indian grass also is very noticeable—that on the contoured field is taller and thicker than that on any comparable area. Appar-

ently more blue grama is present in the contour-furrowed field. Triple awn grass on the badly eroded land crossed by the 13-year-old contour furrows appeared much thicker than that on similar sites not furrowed. The one grass which seemed to be just as dense on the check area as on the contoured field was fall witchgrass, which because of its nature of growth may be more difficult to judge by a preliminary observation.

The conclusion based on unbiased judgment of results, taking into consideration the value of cover for erosion control, the economic value of the vegetation, and the possible damage preventable by proper maintenance, is that the contour furrows have been well worth while.

LIVESTOCK INDUSTRY BENEFITS

(Continued from p. 71)

ships (butterfat prices as compared to feed prices and the general price level of other Corn Belt products) have been the dominant factor influencing the expansion of dairying in Iowa in the past; they probably will continue to be.

“... Moreover, it appears that when the farmers have plenty of grain they feed considerable quantities of it to other than their fattening cattle. If grain becomes more scarce, it may take considerably more roughage to grow the present number of cattle in Iowa. Also, uniformity of range cattle makes them favored over the ‘native’ feeders by the commercial cattle feeders. In view of these conditions it would appear that the future demand for range cattle will be more closely related to market price trends than to crop acreage changes.”

It has been observed in all parts of Iowa that the farms having more than the average amount of grass have more livestock of all kinds than farms having less than the average amount of grass. But it does not follow that decreasing the corn acreage and increasing the pasture acreage in Iowa will increase the total livestock production of the State and other areas to which Iowa now ships feed.

The following findings, based on an analysis of the data presented in this bulletin, are of particular significance in the development of a soil conservation program for the Corn Belt:

“Moderately increased acreages of soil conserving crops may be expected to have little effect on total feed production in the State, except over a long period of time, tending to maintain it at a higher level than would be possible if present depletion is allowed to continue, especially on the highly erodible soils.”

³ Querna, Glenn M.: 620 Miles of Contour Furrows Stabilize the Pocatello Hillsides. SOIL CONSERVATION, January 1938, p. 171.

Problems Affecting the Establishment of Grass in the Great Plains

By C. R. Enlow¹

DURING recent years it has been increasingly difficult to obtain successful results from the seeding of grasses, legumes, or mixtures for permanent pastures, meadows, waterways, and terraced outlets, particularly in the eastern portion of the Great Plains States and sections of Iowa and Missouri. Although the Service has been working directly with thousands of farmers, following the best recommendations of the State experiment stations, in general the results have been disappointing.

RECENT publications by the Illinois Farmers' Institute,² the Weather Bureau,^{3 4} and the Soil Conservation Service, U. S. Department of Agriculture,^{5 6 7 8} present some extremely interesting data regarding the trend of precipitation in the region outlined above. Examination of this literature and additional calculations from weather bureau records, reveal a rather striking point, namely, that at several weather stations the precipitation has shown a varying downward trend since weather recordings began (graphs A, B, C, D). While there is no reason to expect the downward trend to continue, present conditions must be recognized as they are of considerable significance to agronomists and others interested in the successful seeding, growing, and harvesting of crops.

It has been pointed out⁷ that precipitation is due almost altogether to moisture carried by enormous air masses of marine origin as it is precipitated when cooled by contact with air masses originating in polar regions. From this it becomes apparent that man's activities on the land can have little if any effect on precipitation. Likewise, some individuals have surmised that the enormous wheat acreage of past

decades (graph E) in Kansas, Nebraska, and adjoining States is partly responsible for decreased precipitation. Apparently this theory also is incorrect. Farming practices, such as plowing up and down hill and leaving the soil with inadequate cover, have greatly increased the rate of run-off. As a result, a smaller proportion of the rainfall has been available for crop production, thereby accentuating the effects of reduced rainfall.

There has been a tendency to blame unsuccessful seedings on the particular weather conditions and grasshopper invasions, and rightly so. But it becomes apparent that losses of organic matter, topsoil and moisture, through oxidation, erosion and increased run-off must also be considered; in addition, we must give our attention to the downward trend in precipitation and the upward trend in summer temperatures (graphs F, G, H, I). With lessened precipitation, it seems logical that summer temperatures should be higher in this region of not too abundant rainfall, as green vegetation becomes scarce during extended dry periods. The cooling effect of transpiration is lost when vegetation is no longer green and growing.

The author has for many years been interested in seed mixtures for grasslands and the recommendations of State and Federal agencies regarding the same. A study conducted several years ago indicated that the majority of seed mixtures recommended are largely based upon theoretical considerations and are not the result of experimental work. This statement is not meant as adverse criticism, as the physical limitations in conducting field tests with mixtures, involving several grasses and legumes, are readily recognized.

Many of the mixtures now in use are based on observations made over a long period of years. In the

¹ Principal agronomist, Soil Conservation Service, Washington, D. C.

² Kincer, J. B. Is our climate changing? Ill. Farmers' Inst. 1937-1938.

³ Reed, Charles D. Secular trend of Iowa precipitation. Reprint from Monthly Weather Rev. v. 58, pp. 139-142. Apr. 1930.

⁴ Mattice, W. A. Precipitation in the Northern Great Plains. Reprint from Monthly Weather Rev. v. 62, pp. 445-447. Dec. 1934.

⁵ Thornthwaite, C. Warren. The Great Plains. Offprinted from Migration and economic opportunity, Chapter 5, pp. 202-250.

⁶ Thornthwaite, C. Warren. The life history of rainstorms: Progress report from the Oklahoma Climatic Research Center. Reprinted from The Geographical Rev. v. 27, No. 1, pp. 92-111. Jan. 1937.

⁷ Holzman, Benjamin. Sources of moisture for precipitation in the United States. U. S. Dept. Agr. Tech. Bull. 589, Oct. 1937.

⁸ Thornthwaite, C. Warren. The hydrologic cycle re-examined. Reprinted from SOIL CONSERVATION, v. 3, No. 4. Oct. 1937. pp. 1-8.

case of the area under discussion, there is a distinct change of conditions, brought about by decrease in rainfall and increase in summer temperature; we cannot hope for identical results, under present conditions, from seedings of the mixtures of 25 years ago. Furthermore, the organic matter in the soil has been depleted, so that moisture is not retained by the soil in the quantity nor for as long a period as it formerly was. Erosion has removed much of the fertile topsoil, and run-off is accelerated. With less rainfall, higher temperatures and the consequent higher evaporation, less storage for water in the soil, and a higher percentage of loss of the rain through run-off, we can scarcely expect the seed-mixture recommendations made some years ago to be applicable to present conditions.

To illustrate the point in question, let us refer to graphs A, B, F, and G. In 1910 the average precipitation at Topeka, Kans., according to the trend line,

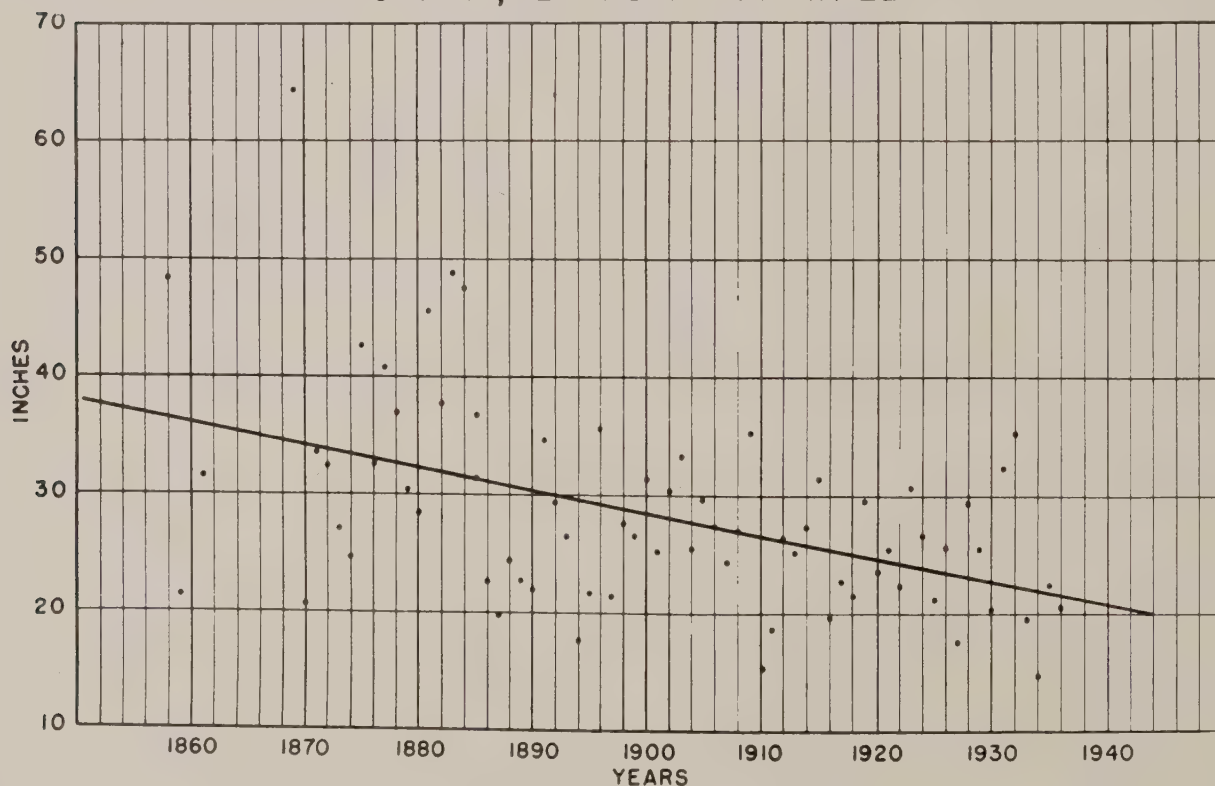
was 32.6 inches and the high temperature was 101.8° F. In 1935 these figures had changed to 31.4 inches and 105.6° F. At Omaha, Nebr., in 1910 the average precipitation was 26.3 inches and the high temperature was 100.4° F. In 1935 the readings showed 21.9 inches and 103° F.

The Nebraska Extension Service⁹ in 1933 recommended the following seed mixture for permanent pastures:

Mixture:	Pounds per acre
Bromegrass.....	7
Orchard grass.....	4
Timothy.....	3
Red clover.....	4
Sweetclover.....	4
Meadow fescue.....	3
Total pounds per acre.....	25

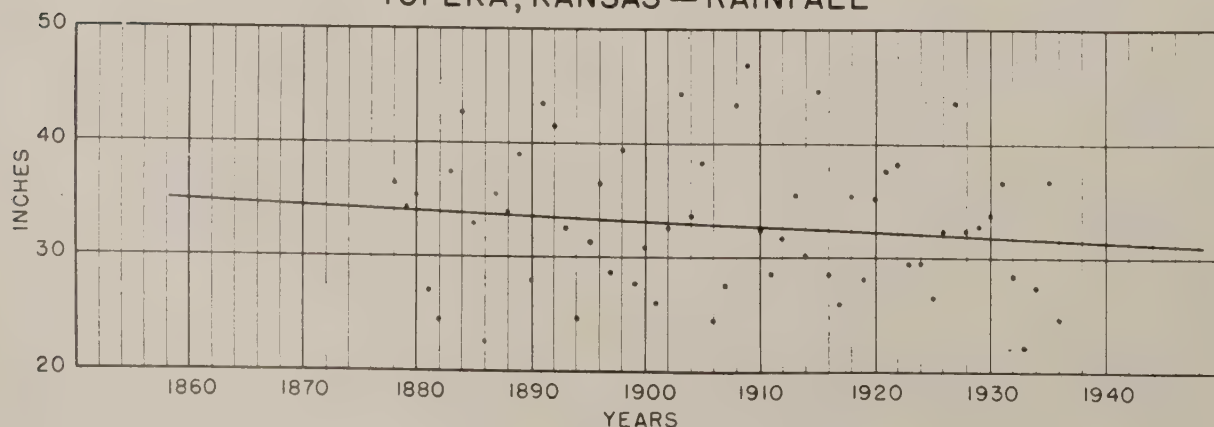
⁹ Stewart, P. H., and D. L. Gross. Permanent and temporary pastures for Nebraska. Nebr. Ext. Circ. 102. pp. 1-15, Reprinted, Aug. 1933.

OMAHA, NEBRASKA — RAINFALL



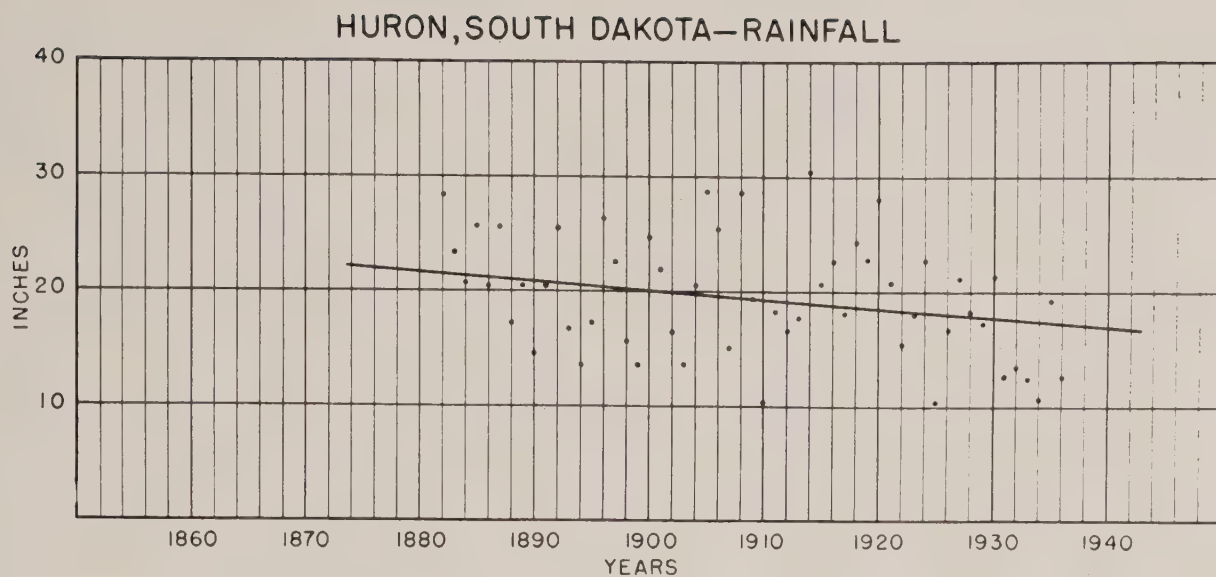
A

TOPEKA, KANSAS — RAINFALL

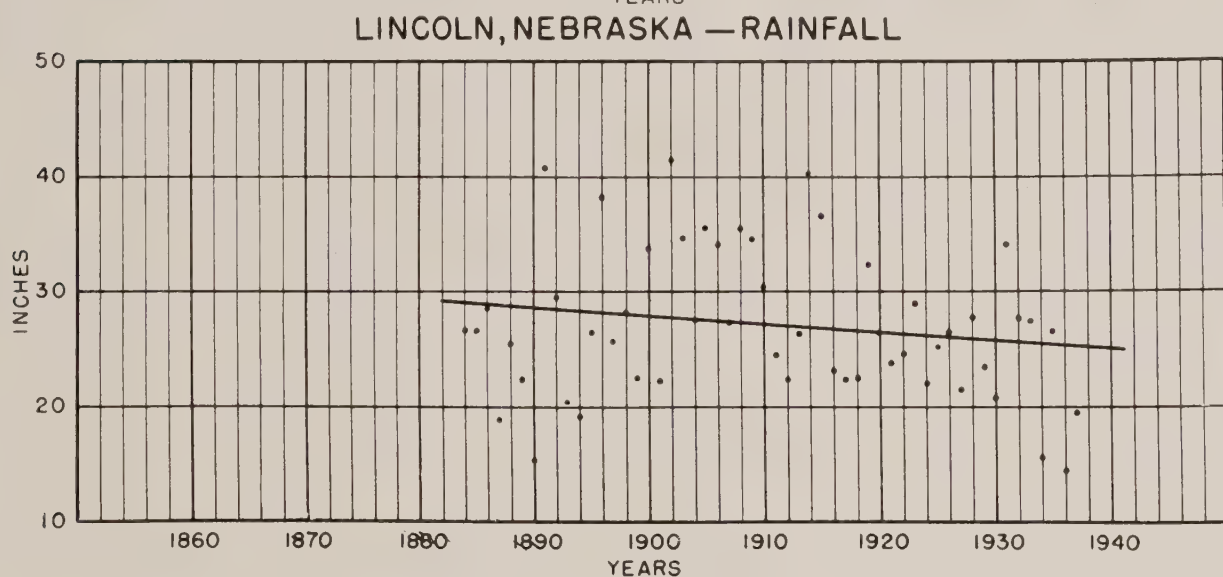


B

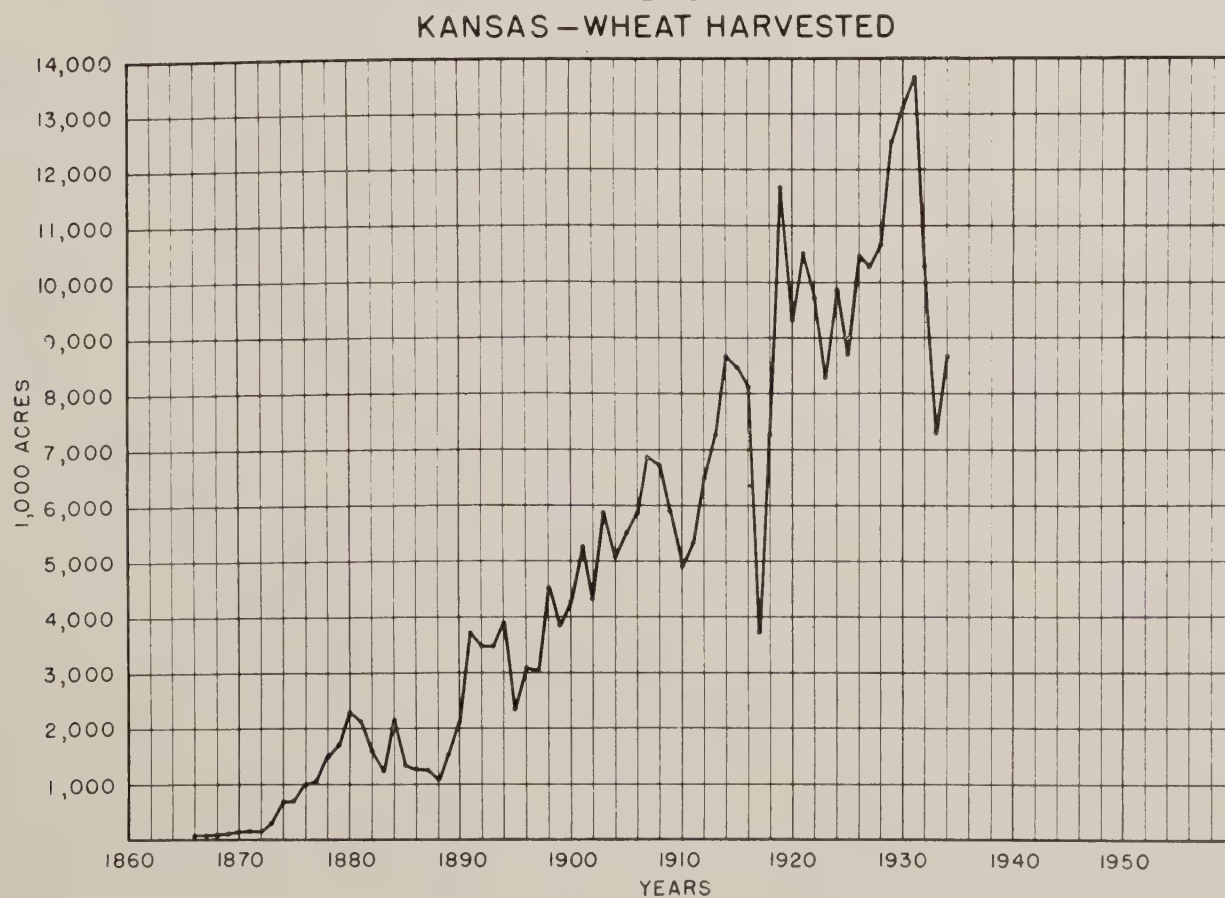
C



D



E



The Kansas Experiment Station ¹⁰ in 1931 recommended the same mixture with some variation in percentage of composition, and with Kentucky bluegrass in addition for northeastern Kansas. The recommendation for east central Kansas was as follows:

Mixture:	Pounds per acre
Redtop.....	6
Orchard grass.....	6
Meadow fescue.....	6
Kentucky bluegrass.....	2
Alsike clover, white clover, or sweetclover.....	4
Total pounds per acre.....	25

Examination of seedings based on these and similar recommendations made the past three years on many farms in eastern Nebraska and Kansas reveals a very disappointing situation. In many instances the seedings were total failures. In most other cases some brome grass and sweetclover survived, but the stands are very poor. The Nebraska station has recognized the difficulty of obtaining good stands from the above mixtures, and, as a consequence, recommendations for the eastern part of the State were changed, in March 1938,¹¹ to the following:

Mixture:	Pounds per acre
Brome grass.....	14
Alfalfa.....	4
Total pounds per acre.....	18

or the mixture shown below:

Mixture:	Pounds per acre
Brome grass.....	10
Timothy (or orchard grass).....	4
Alfalfa.....	2
Sweetclover.....	2
Total pounds per acre.....	18

The Kansas station has also changed mixture recommendations considerably in view of the adverse conditions encountered in recent years. The following mixture is now recommended for average soil conditions in eastern Kansas:

Mixture:	Pounds per acre
Brome grass.....	8
Orchard grass.....	6
Meadow fescue.....	4
Korean lespedeza (acid soils) or sweetclover (non-acid or limed soils).....	4
Total pounds per acre.....	22

It is encouraging to note that the State experiment stations are attempting to meet changed conditions by modifying seed mixture recommendations; this indicates a general recognition of the greatly changed

conditions for the seeding of grasses and legumes in the eastern Great Plains. Actually, a majority of the weather station records from central North Dakota to central Texas and from eastern Colorado to eastern Iowa show a downward trend in precipitation, although not as marked as at Omaha, Nebr. Changes in summer temperatures are also noticeable, and because of loss of organic matter and topsoil, soil conditions are considerably different.

The Soil Conservation Service is launched on a Nation-wide erosion control program in which vegetation plays a major part. The very best information available must be used by Service agronomists, and it is essential that we work very closely with technicians of the State experiment stations. It is highly important that we have their advice in the field where results can be observed; and suggested changes in mixtures, tillage and seeding operations should be discussed freely. The possibility of elimination, from mixtures of those grasses and legumes that are failing to give results, should be discussed both from the standpoint of obtaining results and as to economy. It is wasteful to plant seeds that do not give results.

Considering recent developments in harvesting seed of native grasses, it may be possible to rely to a considerable extent on these developments in deciding upon mixture seedings for the region under discussion, provided practical seeding methods can be developed, and results to date are rather encouraging. It seems apparent that a firm seedbed with a trashy surface offers much better opportunity for the establishment of a good stand than does a clean seedbed, regardless of the thoroughness with which the soil has been prepared. The mulch of wheat stubble, weeds, crabgrass, and other trash offers excellent protection to the emergence and survival of the seedlings. The mulch prevents formation of a soil crust, retains surface moisture, and offers protection against excessive sun and wind. When moisture is plentiful and grasshoppers are not too numerous, early fall planting is a good practice. Late fall planting in wheat stubble gives excellent results in some places, particularly where grasshoppers are too plentiful for early fall planting; the seedlings get a very early start in the spring. Spring seedings are sometimes successful, but are more subject to periods of drought and to grasshopper attack.

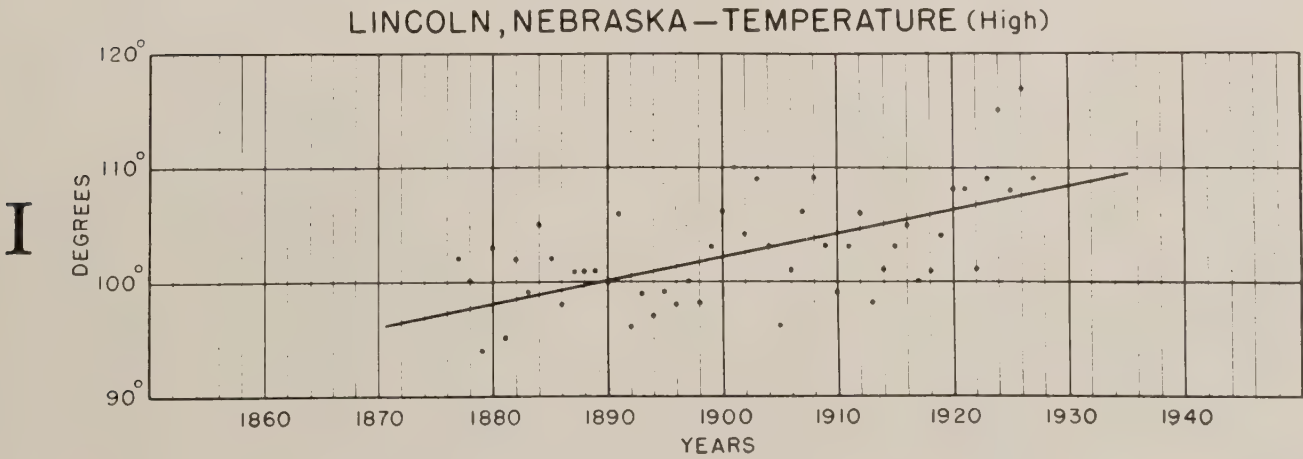
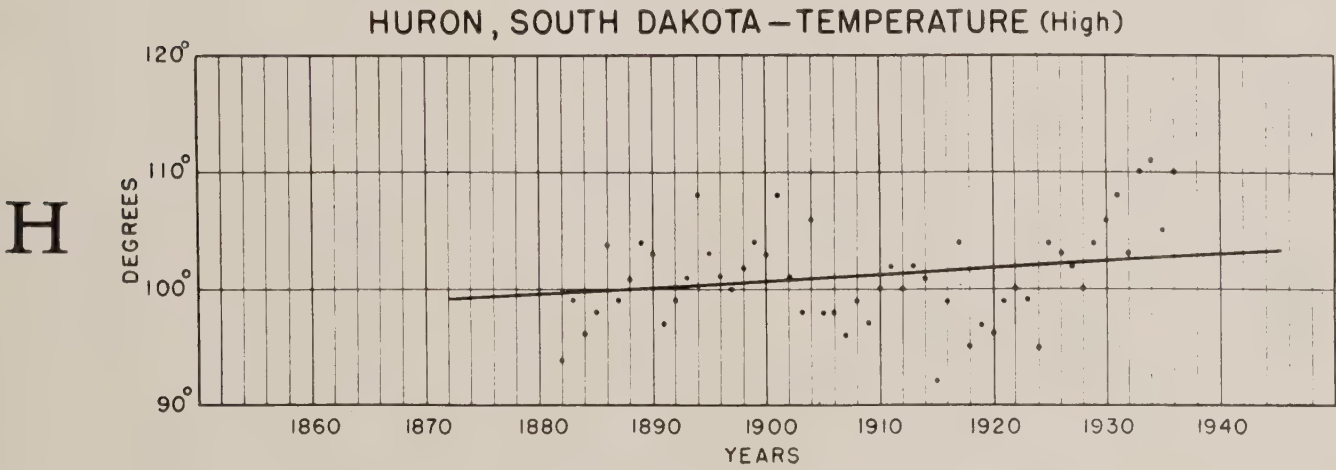
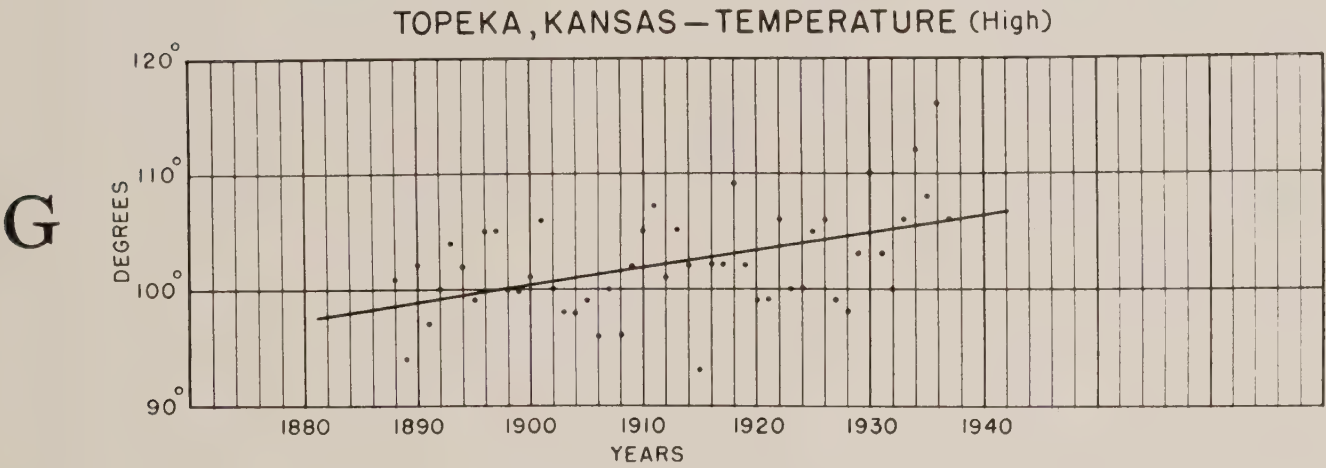
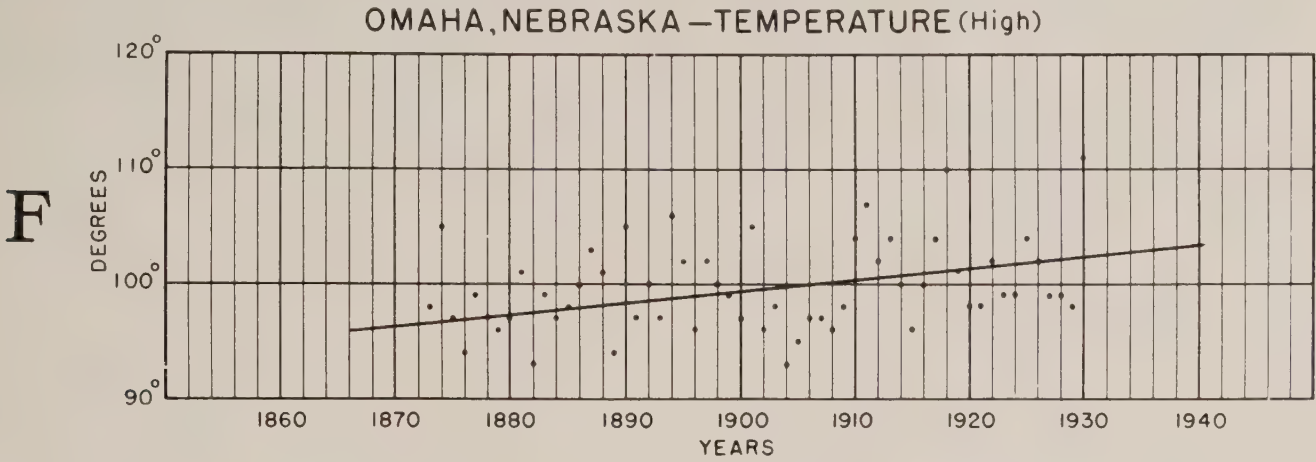
Agricultural experiment stations have been seriously handicapped for lack of funds to study grasses and grass problems. More information has been secured in the past few years than in many years previous, and it is hoped that the material presented here will

¹⁰ Aldous, A. E., and J. W. Zahnley. Tame pastures in Kansas. Kans. Agr. Exp. Sta. Bull. 253. Jan. 1931.

¹¹ Frolik, A. L., and E. F. Frolik. Seeding and management of Nebraska pastures. Nebr. Ext. Circ. 138. March 1938.

point out the serious need for additional information. It is becoming increasingly evident that a truly permanent agriculture calls for more extensive use of

grass, to maintain or improve the organic matter in our soils, and to prevent actual loss of our soils through erosion.



Economic Units for the Dust Bowl

By W. R. Watson¹

IMPROPER land use, abandonment of farm lands, short-term land tenure, and the economic condition of present operators are important and limiting factors in planning a complete soil and moisture conservation program in the Dust Bowl and bordering areas. Much of the grassland of the southern Great Plains was put into cultivation during years of excessive moisture and high commodity prices. This transition from grazing to farming caused land ownership to pass into the hands of small owners and operators, many of whom were nonresidents. Very few of these individual land ownerships constitute economic units that are practical and adaptable to the area. This fact, combined with the successive years of drought, has caused a very high percentage of abandonment in the Dust Bowl area.

Irresponsible operations on these nonresident owned lands is one of the principal causes of the inception and continuance of the wind erosion hazard. The general practice in the past was for lessees to operate on a year-to-year basis. This short-term land tenure is not conducive to the adoption of sound conservation practices. Cultivated fields are neglected and allowed to blow. Pastures are overgrazed and damaged under this system of land use. Because of successive crop failures many of the land operators remaining in this area are financially unable to put into effect the practices necessary to control wind and water erosion.

The foregoing conditions have hindered the furtherance of a sound program for the Farm Security Administration as well as the Soil Conservation Service in this area. Realizing the urgency of the situation and the necessity for certain adjustments in the Dust Bowl area, if land abuses are to be stopped and if those who need assistance are to be rehabilitated, the Soil Conservation Service and the Farm Security Administration are now cooperating in a joint program.

The principal objectives of this cooperative program may be summarized as follows: To establish economic units by consolidating several small ownerships of land into one unit of sufficient size to maintain a family on a satisfactory basis while following a type of agriculture adaptable to the land of that area; to con-



The former occupant of this adobe house on a 320-acre farm in Eastern Colorado farmed up and down hill and depended upon "open range" for pasture for his work horses and milk cows. He did not establish reserve feed supplies. His principal income was from cash crops which, during recent drought years, proved insufficient. He found it necessary to supplement his farm income by working on relief work projects. The farm is not regarded as an economic unit for the area.

On another 320-acre farm in the vicinity is the house pictured below—its occupant, the former resident of the adobe dwelling. Here, too, was once an uneconomic unit, with cash crops, livestock and "open range" the main reliance. The man sold his cattle, left the place, principally because he did not control sufficient range lands for his needs.

Through cooperation of the Soil Conservation Service and the Farm Security Administration the present tenant has obtained long-term leases on 2,240 acres of non-resident owned pasture lands adjoining. What was formerly "open range" has now been fenced. Soil and moisture conservation structures, including contour furrows and stock dams, have been installed. Ninety-two acres of cropland have been terraced. All farming is on the contour, with emphasis on the production of feed crops. A two-year feed reserve will be stored at the first opportunity. The operator has purchased a foundation herd of cows, being financed by the Farm Security Administration under a 10-year repayment plan. It is felt that more security has been added to this man's operations and that this reorganized economic unit should provide an adequate income for himself and his family.



¹ Associate range examiner, agronomy and range management section, Soil Conservation Service, Amarillo, Tex.

trol, through lease or otherwise, the lands in the unit for a sufficient length of time to justify the operator in making improvements in the soil and to give permanence to his enterprise; to include in the operating unit and to restore to grass the adjacent abandoned marginal cropland not needed for crop production by other operators; to adopt and put into effect on the lands of the unit the soil conservation practices necessary for a complete program of soil and moisture conservation; to place principal emphasis on the production of livestock and feed crops and to minimize the production of cash crops in that area.

In order to carry out the objectives of this program several Soil Conservation Service technicians have been detailed to unit reorganization work to cooperate with Farm Security Administration officials. The Service technicians are assigned these special duties: To obtain long-term leases on small ownerships of contiguous lands, and to consolidate these leaseholds into one operating unit of sufficient size to justify livestock and forage-crop production as the major enterprises; to work out farm management plans for the unit as established, and to plan a complete soil and moisture conservation program for the lands involved. All planning is predicated upon a 10-year program for the unit operator. Planning the size and type of unit to be developed requires the closest cooperation of the Farm Security Administration and the Soil Conservation Service. The unit, as developed, must fit the needs and capabilities of the Farm Security Administration client, and at the same time be so planned as to conform to the principal objectives of the program.

As soon as a unit which is acceptable to the Farm Security Administration has been established a complete plan of conservation operation, based upon conservation and range surveys, is drawn up by the Soil Conservation Service technicians. Into this plan of conservation operations is incorporated a 10-year agronomic, range, and land-use program. Where erosion-control structures are needed, to be built by the operator, the specifications and dates of construction are definitely stated. This plan of conservation operations, signed by the operator, then becomes a part of his Farm Security Administration loan agreement and farm plan.

Loans are then made by the Farm Security Administration. The livestock loans are repayable over a 10-year period. This long-term loan policy makes it possible for the client to establish himself with a foundation herd of livestock. As the marginal croplands, which are being restored to grass in the unit,

become revegetated and increase in livestock carrying capacity, this foundation herd can be increased to the numbers necessary for an economic unit. Forage crops produced on these units are stored for reserve feeds at the first opportunity, so that a balance between feed production and consumption may be maintained over periods of unfavorable moisture conditions. This long-term planning and financing is an impossibility unless long-term tenure is first established.

Many obstacles are encountered in the organization of the economic units. For example, taxes, based upon cultivated land values, are too high in many communities to justify use of the land for grazing purposes. This is particularly true of the restoration land which has little value at first for grazing. Non-resident owned lands are in many cases held for speculative purposes. The owners are concerned only with sub-surface rights and not with surface erosion problems. Leases, in the past, have usually been made from year to year. Land owners who wish to dispose of the holdings do not wish to obligate themselves for more than 1 year at a time. Land investments have in many instances been made on the basis of productive cropland. A great deal of land in this area is owned by speculators who are waiting for favorable moisture conditions to dispose of their holdings as cropland. In certain areas there is little or no grassland left to be used as the basis of support for the foundation herd. In other areas much of the nonresident owned and abandoned land has virtually reverted to "open" range. This "open" or "free" range is generally used by large operators, many of whom are transients. Naturally, this class of operator does not favor a program in which one of the basic principles is controlled grazing, which in turn implies fencing of ranges. A program based upon a livestock economy does not offer the speculative possibilities that a cash crop offers. Many farmers in the area are still waiting for that one bumper crop to cure all their economic ills, forgetting that in the interim, with continued erosion, their chances of growing that crop are being reduced each year.

In spite of all of these major obstacles and many others of local or minor importance, a great deal of progress has been made by the Soil Conservation Service and Farm Security Administration since this cooperative program started in 1938. Most farsighted operators in the Dust Bowl realize that the area is primarily adapted to livestock and forage-crop production; and the majority of the Farm Security Administration clients, or those who are eligible for

(Continued on p. 88)

Roads Open—and Farms Secure



An Arkansas highway with vertical banks and sharp ditches.



The same highway as above, after roadside cuts were sloped and sodded for erosion control, safety, and beautification.

*By Arnold Davis*¹

HIGHWAY right-of-way erosion-control projects and demonstrations being carried on in Region 4 now include 6 demonstrations on State and Federal highways, 12 protective projects on State and Federal roads, and 28 protective projects on county roads. Of these totals, 3 demonstrations, 9 protective projects on Federal and State highways, and 19 county protective jobs are being completed by camps and projects in the Region 4 sector of Texas. Two demonstra-

tions, 3 protective projects on State and Federal highways, and 7 county protective jobs are located in Arkansas. One demonstration on a Federal highway and one county protective project are located in Louisiana.

According to Louis P. Merrill, regional conservator, farmers, highway engineers, and the traveling public now recognize that highway erosion damage is caused by deposits of soil washed from adjoining farm lands and by direct erosion of cuts, fills, and embankments. The presence of raw, unprotected gullies and ditches along highways leads to the eventual destruction of farm land by continuous caving and spread of ditches

¹ Engineer, in charge highway erosion control, engineering section, Soil Conservation Service, Washington, D. C.

into farm fields. Spread of roadside ditches produces gullies in farm fields and necessitates the frequent relocation of fences paralleling the road. The ditches also spread toward the highways, threatening to undermine the roads. This raises highway maintenance costs.

Control programs now being effected make use of two methods—vegetation for cover and mechanical structures. Soil-holding grasses, shrubs, and vines are planted in erodible spots along the roadway. Deep ditches are eliminated by resectioning the right-of-way—by sloping and filling the ditches to produce wide, shallow waterways covered with sod or other stabilizing vegetation. Extensive use is made of the drop inlet culvert which protects fills and embankments and cuts down soil washing on adjoining farms.

The demonstrations were set up to determine the most practical and economical methods of roadside erosion control, and to point the way for cooperation among individual farmers and highway departments and county road officials.

"Farmers have been quick to realize that roadside protection work increases the value of their lands, reduces the erosion hazard threatening adjacent fields, and provides a safe, vegetated waterway on which they can empty terrace water," Mr. Merrill said.

The protective work also reduces the traffic hazards, ensuring safer motor travel over the protected routes.

The roadside protection work on a State highway north of Forrest City, Ark., may be cited as an example of projects which have received the approval of landowners and farm operators.

Before work was started on this 2½-mile stretch of road, in the fall of 1937, vertical banks of ditches on both sides of the highway ranged from 2 to 15 feet deep, and erosion was advancing at an alarming rate. Fences bounding farm fields all along the road were dropping into the ditch as caving continued. It is estimated that 12,000 cubic yards of soil had been washed away from the section since the construction of the highway in 1934.

Protective improvement eliminated ditches and substituted a wide, shallow, sod-protected waterway of gentle slope. Farmers along the stretch donated the additional right-of-way needed. Ditch banks were caved in, fills were made and the sloping right-of-way was extended back a few feet into farm fields.

V. O. Turner, who operates a 1,488-acre farm, part of which lies along the section of road which is being protected, said that it would have been necessary for him to move fences back frequently if the road work had not been instituted. "My land was caving off

in the ditch all along the road. This was happening in spite of the fact that my pastures over which the water flowed before reaching the ditch caught and held most of the rainfall," he said.

Commenting on a county road project nearing completion at Heber Springs, Ark., W. B. Farmer, who owns 60 acres adjacent to the 2-mile road stretch being protected, said:

"This roadside work has been worth more than \$300 to me alone. Before it was done there were times when cars couldn't get through because rains washed draws in the road. It was dangerous to pass another vehicle on the road because of the ditches on either side. The work has helped to eliminate the mud, because water doesn't stand in the depressions. The ditch was cutting into the road all the time, making it narrower.

"Grading helps a road, of course, but grading can't stop it from washing away. It takes good heavy sod to check the cutting power of the rainfall. The sodding done along this road will make it possible for the water to run off without doing any damage. It'll keep the road from washing out."

Maintenance costs along this stretch of highway were high prior to protective treatment. Primary maintenance now consists of periodic mowing by the farmers who till the land adjacent to the highway. The protective work makes it possible for the farmer to harvest a hay crop, in addition to controlling erosion on farm land and highway.

The Arkansas Highway Department announced recently that right-of-way protection of the same type as that used on the demonstrations will be used on long road stretches now under construction. An instance of this is the 50-mile stretch between Monticello and Jonesboro. Engineers announced that banks will be sloped to provide a maximum grade of a 1-foot drop in each 3 feet and will be sodded to prevent erosion.

GRAZING PROGRAM IN DRYLAND SECTION

(Continued from p. 68)

mately one mile of fence to eliminate stock trespass and give exclusive use and control of the grazing to the cooperator.

This type of program on livestock ranches is receiving much attention from ranchers in this area. Together with the aid of the county agents and the A. A. A. range program, it is serving to educate the ranchers, to make them conscious of the grazing problems on their ranches and anxious for help in solving them.

The Native American *Lespedezas*¹

By A. J. Pieters²

TWENTY species and several varieties of lespedeza have been described from the United States. Of these, eleven species are widely distributed and any one of them may be found anywhere in Regions 1, 2, 3, 4, 5, and in the eastern part of Region 7. In addition, two other species have a more limited distribution, *L. leptostachya* having been reported only from Region 5, and *L. simulata* while occasionally found in the East being confined mainly to Missouri and Oklahoma.

The value of these native species for erosion control has not been determined. In the wild state they are seldom found in close stands, but rather as single plants or as small groups of plants. Growth of this kind is of little value for erosion control but it is possible that some means may be discovered by which good stands may be obtained. One man in Alabama claims to have secured a good stand, but practically no other work has been done with these species. Most of them have been grown by the Bureau of Plant Industry on the Arlington Farm nursery where it was necessary to scarify the seed before stands could be secured.

The seeds of lespedeza species are known to be of some importance as food for birds, especially quail, and they may therefore be useful in wildlife plantings. All the species inhabit rather dry and barren situations, the edges of woods, gravel banks, and pine barrens being frequent habitats.

The object of this discussion is to call attention to these lespedezas, to attempt such nontechnical description as will be usable, and at the same time to point out the distinguishing features of at least the more common species. Only the eleven most common species will be described. The others resemble so closely some of the species described that it would be difficult or impossible to distinguish them by a nontechnical description and nothing would be gained by doing so.

¹ The May 1938 issue of SOIL CONSERVATION carried an article, "Lespedeza Relationships" by Dr. Pieters.

² Principal Agronomist, Soil Conservation Service, Washington, D. C.

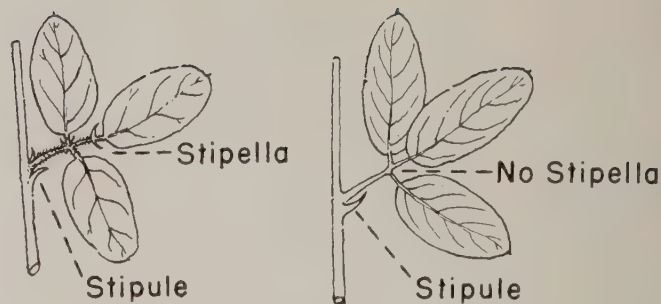


Figure 1.

Before discussing the lespedezas, it may be well to point out that this group is closely related to the beggar weeds, the small-leaved species of which might be mistaken for lespedezas when no flowers or fruits are present. The two groups are readily distinguished, however, by the small growths called stipellas at the base of the leaflets. Both beggar weeds and lespedezas have stipules at the base of the leaf, but only the beggar weeds have the stipellas at the base of each leaflet. This may be clearly seen by the drawings shown in figure 1.

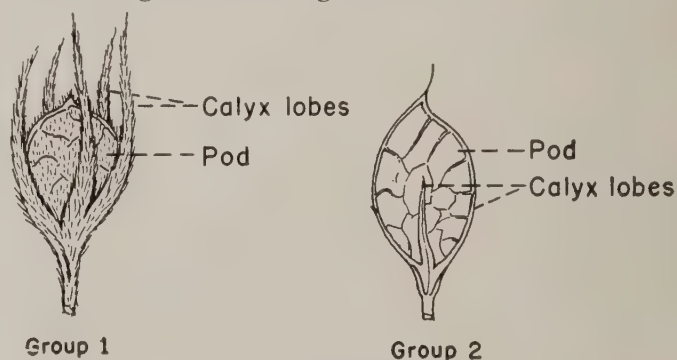


Figure 2.

L. striata and *L. stipulacea*, the introduced annual species which are common everywhere as far north as southern Illinois and Indiana, and *L. bicolor*, an Asiatic perennial which is occasionally found as an

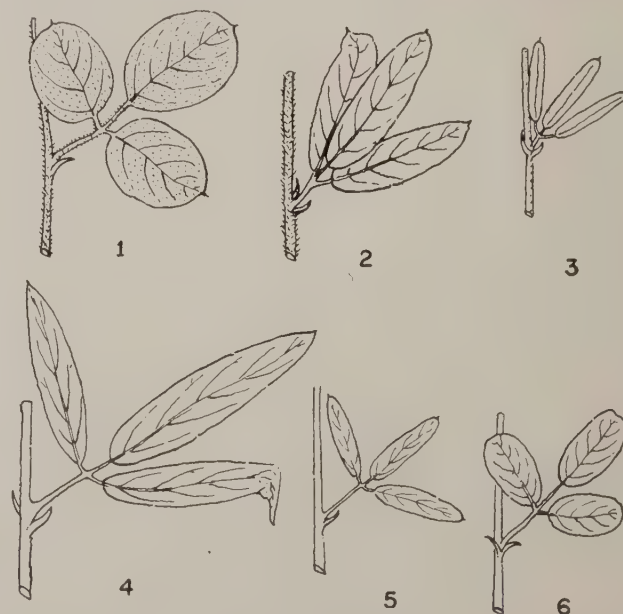


Figure 3.

escape in the South, are not natives of America and are not discussed here. Our native species fall into two groups: those with one kind of flower and those with two kinds. This character is not easy to use, but fortunately it happens that two other characters readily seen are associated with this, namely, flower color and length of the calyx lobes in relation to the flower and pod. Figure 2 shows the relative length of calyx and pod. Let us then divide the species into two main groups as follows:

Group I.—Flowers yellowish, lobes of the calyx about as long as the flower and longer than the pod. Pods very hairy.

Group II.—Flowers red or purple, calyx lobes about $\frac{1}{3}$ to $\frac{1}{2}$ as long as the pod (except *L. simulata*). Pods little or not at all hairy.

To Group I belong *L. hirta* and *L. capitata* with the closely related species *L. angustifolia* and *L. longifolia*. All the others belong to Group II. In this group, *L. simulata* is exceptional in having long calyx lobes and a hairy pod, but the flowers are purple.

In Group I, *L. hirta* is readily distinguished from *L. capitata* by its broad rounded leaflets. In fact this species is the only lespedeza having broad rounded leaflets and without hairs on the upper surface but hairy below. Drawing 2 of figure 3 shows the shape of the leaflets. *L. hirta* is a tall coarse growing species 4 to 5 feet high and often well-branched. The flowers are borne in long dense spikes on stalks longer than the leaves. In *L. capitata* the flowers are borne in dense clusters at the end of the main stem or on short branches near the top of the stem, and the stalk of each cluster is shorter than the leaves. The leaflets in *L. capitata* are oval or long, from two to five times as long as broad, and very hairy below—often so hairy as to be silvery. This species usually has but a single stalk which may be somewhat branched at the top but is often quite unbranched.

In *L. angustifolia* the flower clusters are borne on long stalks and the leaflets are long and narrow, several times as long as wide. In *L. longifolia*, the leaflets are very long and evenly narrowed toward both ends, the tip acute.

Of the species in Group I, *L. hirta* would appear the most promising for erosion control. The others usually afford little ground cover.

The species in Group II may be divided and described as follows:

PLANTS PROSTRATE:

Stems nearly smooth or with ap-

pressed hairs *L. repens*.

Stems with spreading hairs *L. procumbens*.

PLANTS ERECT:

Flower cluster open, on long stems few in a cluster, stem smooth or slightly hairy *L. violacea*.

Flowers in clusters, on stalks longer than the leaves, stems hairy *L. nutallii*.

Flower clusters dense, sessile or nearly so in the leaf axils on the upper part of the stem or often for a considerable distance down the stem:

Leaflets narrow, same width throughout *L. virginica*.

Leaflets broad, usually not more than twice as long as broad:

Leaflets thin and with few hairs *L. frutescens*.

Leaflets very hairy, often silvery *L. stuvei*.

L. simulata is so much like *stuvei* that it is difficult to distinguish when not in flower. It is rare in the East but more common in Missouri and Oklahoma. The two species in the prostrate group are distinguished by their habit of growth which is trailing. They sometimes make a dense growth three to four feet in diameter. They are much alike and both occur everywhere, but *L. repens* has a stem only slightly hairy while that of *L. procumbens* is rough hairy. A third species, *L. texana*, is said to differ from *L. repens* in its larger pods and leaflets, but there is doubt that this distinction will always hold and in any event the species is so near to *L. repens* that no harm will be done if the two are confused.

These three species have leaflets which are broadly oval, about twice as long as broad, or shorter. Their usefulness, if any, is limited by the difficulty of harvesting seed from the prostrate branches.

L. violacea is an erect species but bushy, fine-stemmed, and sometimes the branches droop so that it seems almost like *L. repens*. The leaflets resemble those of *L. repens* and while there is a technical difference in flower arrangement, this is not always clear. Herbarium specimens of this species are easily confused with *L. repens*, but in the field it will be found that *L. violacea* is always erect, especially in the lower part of the stem, while *L. repens* is always prostrate.

L. nutallii might be confused with sparsely flowered forms of *L. hirta* as far as flower arrangement is concerned; but the flowers of *L. nutallii* are violet purple instead of yellowish as in *L. hirta* and the leaflets are long oval—longer and narrower than in *L. hirta*.

When only leaves are present, *L. nutallii* might also be confused with *L. frutescens* and with *L. stuvei* since the shape of the leaflet in these three is similar. The hairs on the stem of *L. nutallii*, however, are spreading, while those on *L. frutescens* are appressed. *L. nutallii* may be distinguished from *L. stuvei* by the less hairy leaflets, those of *L. stuvei* being densely, often silvery hairy.

L. frutescens and *L. virginica* are probably the most hopeful from an economic standpoint. *L. frutescens* is a common species, erect, usually well-branched or even bushy. The leaflets are usually thin, oval or somewhat elongated in shape and variable in size, hairy below but with few or no hairs above. The flowers are borne in dense clusters, each cluster on a short stalk. The differences between this and *L. nutallii* have been mentioned in the foregoing discussion.

L. virginica is possibly the most common species. It has stems erect, slender and often well-branched, usually one to two feet high, densely leafy with long narrow leaflets of nearly the same width throughout and four to eight times as long as wide. Leaflets are usually without hairs above but somewhat hairy below. The flower clusters are crowded in the leaf axils and occur for some distance down the stem.

L. stuvei is fairly common but not as common as *L. virginica* or *L. frutescens*. The stem is erect, about 18 inches to 2 feet high, and not well branched. The leaflets are the same shape as those of *L. frutescens* but are thicker and very hairy on both surfaces, the under surface often silvery hairy.

It is difficult to construct a key that will separate these species when not in flower but it is thought that the following may be helpful:

PLANTS PROSTRATE:

- Stems with spreading hairs *L. procumbens*.
- Stems with appressed hairs *L. repens*.

PLANTS ERECT:

- Plants low, bushy, leaflets thin . . . *L. violacea*.
- Plants tall, stiff:

- Leaflets rounded, almost as broad as long *L. hirta*.

- Leaflets two to three times (rarely more) as long as broad:

- Stems with appressed hairs or none *L. frutescens*.

- Stems with spreading hairs:

- Leaflets hairy above and below, often silvery hairy below ³ *L. stuvei*.

³ *L. simulata* can be distinguished from *stuvei* only by the color of the flower and by the long calyx lobes.

- Leaflets not hairy above, moderately hairy below . . . *L. nutallii*.

- Leaflets long and narrow, of nearly the same width throughout:

- Leaflets four to ten times as long as broad:

- Few or no hairs above, appressed hairy below . . . *L. virginica*.

- Hairy above, densely hairy often silvery below *L. angustifolia*.

- Leaflets narrowed toward both ends:

- Two to five times as long as wide, densely silvery hairy below *L. capitata*.

- Five to eight times as long as broad, not silvery hairy below, acute at the tip . . . *L. longifolia*.

This key may serve as a guide, but it must be remembered that the size and shape of the leaflets in all these species is extremely variable. There will be plenty of plants on which no two specialists will agree, but the key should enable field men to place the species with approximate accuracy.

An interesting feature of the American species is their susceptibility to rust. The rust is known as *Uromyces lespedezae-procumbentis*, and occasionally affects American species severely. The oriental species are immune from this form of rust, though a rust described under the same name attacks these species in the Orient. This appears to be a case of physiological races in rusts.

Hubam Clover

Apparently, Hubam clover (*Melilotus alba annua*) is one legume that can be grown successfully in competition with cotton root rot. This winter annual makes its growth during a season when the organism causing the cotton root rot is dormant.

The acreage of Hubam clover is increasing rapidly in the Black Belt of Texas as well as in other cotton root rot areas. Farmers are realizing some exceptional returns per acre, as the seed is much in demand and the price per pound is high.

This development appears to indicate that diversification in one-cash-crop regions is the answer to many problems. When proper rotations are worked out, accompanied by a field arrangement that approaches efficient land use, the control of soil erosion becomes much less of a problem.—C. R. Enlow.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



PLANT ECOLOGY. By John E. Weaver and Frederic E. Clements. New York and London. 1938.

This revision will be welcomed by all those who are aware of the importance of a knowledge of the relationships between plants or groups of plants and their environment. The fact that there has already appeared, above the signatures of various reviewers, considerable discussion, criticism and praise concerning changes, additions and omissions in the revised text is in itself proof of its value and of the increasing interest in plant ecological studies. Certainly there is a great quantity of valuable material between pages 1 and 538, and no one is likely to express any objections to the enlarged bibliography—originally there were 601 entries; now there are 1,035. This, too, is evidence of the rapidly growing interest in the subject.

The chapter entitled "Coaction and conservation" will arrest the attention of soil conservationists in particular, as much new and useful information is included and the organization of subjects is interesting and thought-provoking. These few lines from the authors' introduction to the chapter will perhaps give the idea behind the discussion of coaction and conservation under one heading: ". . . destruction [of plants and animals] often involves reaction as well as coaction, and it is likewise true that conservation must combine both of these processes in the proper degree. In nature especially, the numerous coactions of the plants and animals of a community form an intricate network of processes, most of them still awaiting detailed study. In consequence it proves desirable to select for treatment a few outstanding examples as representative of the various types. Such as pollen, seed, and other food coactions on the one hand, and on the other the disturbances caused by man directly or indirectly, as seen in clearing, lumbering, overgrazing, cultivation, and construction, or in changed populations of animals, such as game, predators, rodents, fish, or insects."

Following this we are given the details of some of the coactions of plants and animals (including humans): Pollination, chiefly by insects; seed production and distribution as disturbed by birds, rodents, and man; coactions of the plant body as affected by the food habits of grazing animals, rodents, and man. It is thus that the authors tie up ecological studies and conservation, nor do they hesitate in proceeding immediately into that section of their book which treats directly with conservation of soil and water. Cultivated fields, pasture and range, forest and chaparral, windbreak and shelterbelt, highways and erosion control, control of floods, wildlife conservation—these are the headings used in a discussion, from the ecological standpoint, of the "basic principle of protection by [plant] cover" and the need for an understanding of helpful coactions and harmful ones in the matter of soil and water conservation methods.

More than half the book is unchanged in the revision, except for the substitution of a different word here and there, as xeric for xeroid and disclimax for subclimax. The chapter on "Methods of studying vegetation" is greatly changed, however, and enlarged to include material on basal area, clip, frequency-abundancy and pantography-chart quadrats, isolation transects, the relict method, pollen analysis, etc. The discussion of "Soil in relation to plant development" is in certain parts new and contains much recent and useful information concerning soil structure, soils development, water-content and factors modifying it, and soil air. Special treatment is given saline soils and acid soils. The chapter on "Soils in relation to plant development" introduces "Reaction and stabilization" with considerable new material in relation to erosion control. The chapter on "Migration, ecesis, and aggregation"

has been rearranged for a more logical presentation, and now constitutes an excellent study of the causes that produce the successive waves of plant populations.

The book throughout places the emphasis on the grassland, and conservationists will find much valuable material for adaptation in range management studies. The chapter dealing with the "Relation of underground plant parts to environment" gives thorough treatment of the subject of root development under varying conditions. Root variations and growth habits as affected by environmental conditions are carefully described and illustrated. Special emphasis is given certain environmental conditions—high water content, low water content, soils rich in plant nutrients, saline and acid soils, soils of loose or compact structures, soils of varying temperatures and aeration. The relation of roots to cultural practices is stressed, and detailed treatment is given the subject of root habits within the community, underground stems and root offshoots, and soil organisms in relation to disease.

That section of the book which treats of light as one of the most important factors determining the growth of plants and the development of vegetation has been rewritten to include a great deal of new material which is particularly adaptable to the problem of extending the northern or southern range of crop plants.

There is no doubt that this revised edition of *Plant Ecology* will be widely used, as no other text brings together so much material from the diverse fields of the study of plant growth and distribution. Ecologists will point out minor errors and inconsistencies of organization; but the soil conservationist with profound interest in plant cover as protection from erosion will greatly appreciate the volume as a concise and carefully organized presentation of the material. As a matter of fact, the conservationist will not read very far before he will realize that in compiling the revision the authors' objective was to build up a text on plant ecology that would place strong emphasis upon the importance of plant cover in stabilizing soil against erosion by wind and water.

THE PROBLEM OF SOIL EROSION IN THE BRITISH EMPIRE WITH SPECIAL REFERENCE TO INDIA. By R. Maclagan Gorrie. London. 1938.

This excellent paper is to be found in the *Journal of the Royal Society of Arts*, July 29, 1938. Dr. Gorrie, of the Indian Forest Service, has been seconded for a special study of the old and disastrous erosion in India and here he presents a review of conditions and policies in the light of recently acquired experiences. Into the 24 pages of his discussion he has packed a great deal of information regarding the widely varying problems of Great Britain's far-flung colonial areas. Special characteristics of the Punjab are cited and described as applicable to almost all tropic and semi-tropic countries included in the British Empire: erratic rainfall with torrential storms in mountainous catchments; heavily eroded foothills and silted plains and valleys; heavy concentration of population on areas which should be managed for water conservation; ancient agricultural methods persisting in over-populated areas; increase in animal production as the result of hereditary or religious inhibitions about reducing animal numbers. Aside from these general characteristics, many local problems are pointed out as exceedingly important. Dr. Gorrie stresses the need for ". . . a flexible conservation technique for the reasonable use and development of all land and water resources as they relate to each other, holding as our common purpose the welfare of the people whom we help to serve or govern."

At the beginning of the paper we find an interesting study of



BOOK REVIEWS AND ABSTRACTS

Continued



the effect of plant cover upon soil profiles—forest soil with its layer of humus, grassland soil, ploughland soil with an impervious plough sole, grazing ground with stony and silt-sealed surface. Following this are some fresh statistics on erosion losses in India and a summation of needed surveys to constitute a first step in attacking the erosion problem in severely eroded areas in that country. "Unfortunately," states Dr. Gorrie, "the best individual instance of practical control measures so far produced in the Punjab is of only local importance. This is the Katardhar, the outer slope of the heavily eroded Hoshiarpur Siwalik ridge, whence a series of sand torrents have spread a useless mantle of sand so deep over the surrounding plains that no surface run-off ever reaches the nearest river but is engulfed in the sand. Part of these slopes were brought under legal closure by a local act some 30 years ago, and have recently been further improved by a successful campaign to encourage the voluntary closure of grazed areas and the replacement of uncontrolled grazing by grass cutting. As there is a ready market on the adjoining plains for cut grass the response has been good, and some 60,000 acres of closures have been effected in 3 years . . . The next area now being taken up on the inner slopes of the Siwalik and the adjoining Himalayan foothills is of wider national importance, as the stream-flow from it contributes directly to the Sutlej Canal Colonies where winter water shortage is an acute problem."

In outlining the plans for coordination of erosion control measures in India, Dr. Gorrie has given us an extremely interesting résumé of the work of the recently organized Rural Construction

whose staff members are now preparing improvement schemes, and of the provincial committee of the United Provinces' 5-year plan. The committee is to "examine research projects and initiate fodder and grazing experiments; examine the possibilities of increasing firewood and so do away with the use of cowdung as fuel; develop fodder production from the eroding ravine lands of the Gangetic plain; and extend the system of growing fodder trees under *taungya* cultivation already so successful in the poorer forest types in Saharanpur and Dehra Dun. In this province the fodder requirements amount to 30,000 tons a day; the weight of cowdung burnt yearly is far in excess of the total weight of timber and firewood extracted from Government forests; and there are some 15,000 square miles of uncultivated waste, much of which with proper management could produce more fodder and fuel than it does now . . ." It appears that the problem of soil conservation and land utilization in India is similar in many respects to that of China.

The closing sections of Dr. Gorrie's paper give somewhat brief and generalized descriptions of forest conservation, streambank protection, grassland conservation and improvement, control of farm lands, and legal control of important catchment areas, as planned and initiated in the British Empire as a whole. Those who read this discussion will be deeply impressed by the magnitude of the task confronting the British in their efforts to set up a new standard in land management for the widely separated regions within the Empire.

ECONOMIC UNITS FOR THE DUST BOWL

(Continued from p. 81)

Farm Security Administration loans, are ready and eager to change their system of operations. A report of June 30, 1938, shows that 58 of these reorganized units had been completed and approved by the Farm Security Administration and the Soil Conservation Service.

An analysis of these 58 reorganized units gives the following data: The total acreage before reorganization was 29,180 acres or an average of 503 acres per unit. The total acreage after reorganization was 133,816 acres or an average of 2,307 acres per unit. The total acreage was divided as follows: Range land 99,478 acres; restoration land 14,602 acres; cropland 16,000 acres, and other lands 3,736 acres. The live-stock inventory, including range cattle, dairy cattle, and horses was 16.6 animals per unit before reorganization and 36.2 head after reorganization and purchase. The livestock goal, taking into consideration loan repayments and range and restoration land improvements, is an average of 71.3 animals per unit. Range and restoration land in these units including 114,080 acres are to be grazed and managed as outlined in the plan of conservation operations; 46,977 acres of range land are to be contour furrowed; 54 stock dams are to be built, and 35 springs are to be developed by the unit operators.

Cropland amounting to 14,173 acres is to be contour farmed. Where erosion nonresistant crops are grown they will be planted in a strip-crop pattern with erosion resistant crops.

In addition to the 58 reorganized units which were completed on July 1, 1938 the Service technicians had 64 other units in various stages of reorganization. These 64 units represent an additional 164,000 acres of land which is to be included in the program. Additional requests for this type of work are received daily and it is felt that this coordinated program will render a great service in the Dust Bowl and adjoining areas.

Italian Ryegrass

In the January 1938 issue of this magazine it was pointed out that domestic ryegrass offers excellent possibilities for winter pasture and probably seed production in Oklahoma. No doubt this is also true of Arkansas and northern Texas.

There are many improved strains of Italian ryegrass which are far superior in production to domestic ryegrass. Many of these strains have been under test by the Bureau of Plant Industry for several years and I am of the opinion that some of the strains should be introduced into a locality where a winter pasture that will reseed is needed and where seed production of this plant could be studied.

In this connection, the Bureau of Plant Industry has also tested many improved strains of perennial ryegrass obtained throughout the world. Several of these show promise. Before perennial ryegrass seed is purchased, however, inquiry should be made to the Washington office.—C. R. Enlow.

Publications Pertaining to Pasture and Range Management¹

For **REFERENCE**
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information, U. S. Department of Agriculture

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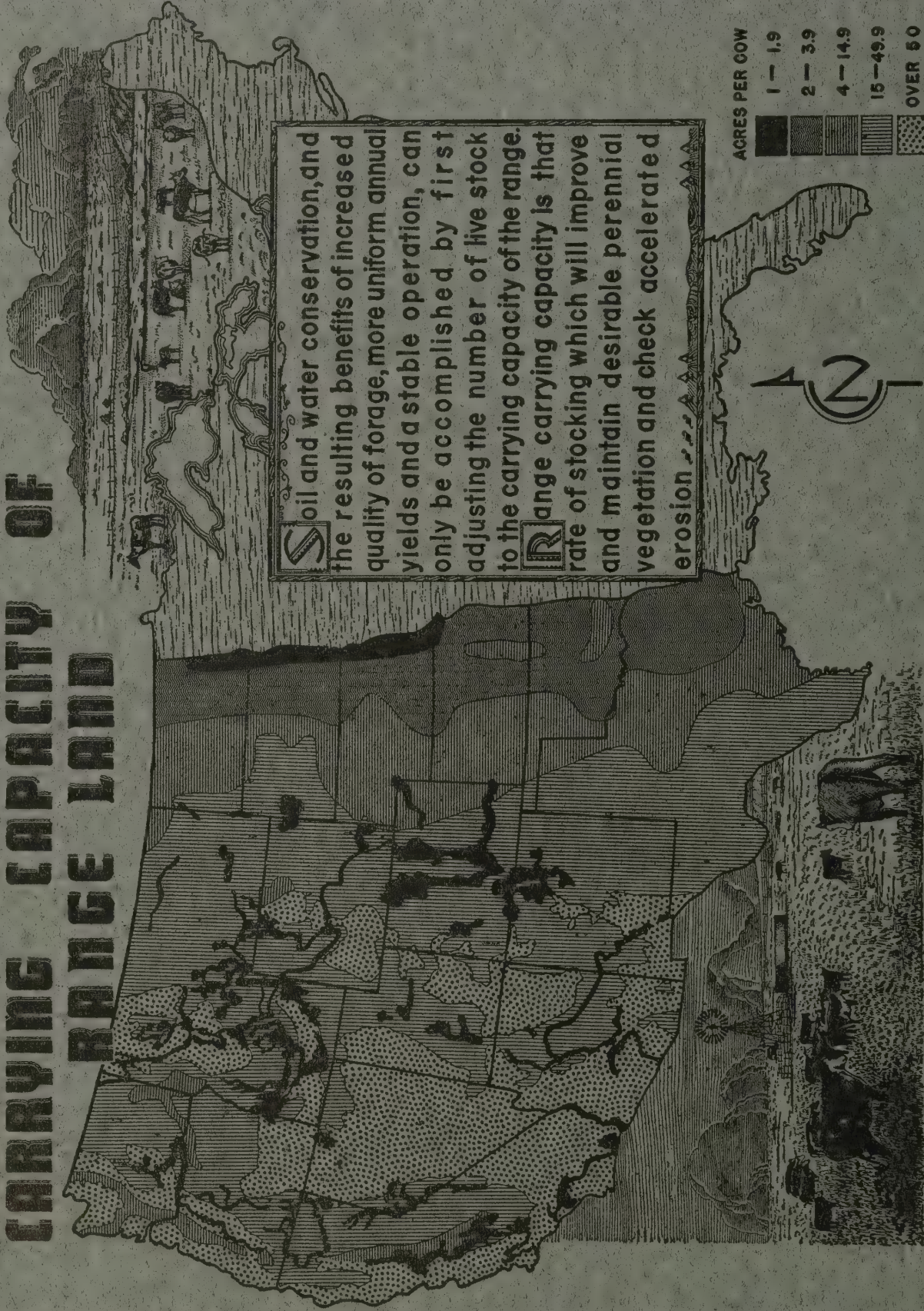
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¹ For additional references, see lists in previous issues of "SOIL CONSERVATION".

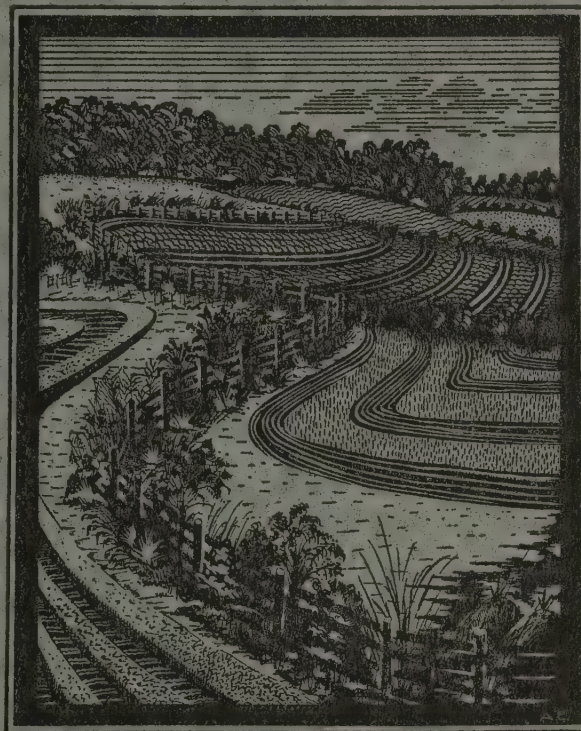
² Out of print. Available to the Soil Conservation Service staff on a loan basis through the Service library. Others may consult copies in depository and principal agricultural libraries.

CARRYING CAPACITY OF RANGE LAND



SOIL CONSERVATION

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Secretary of Agriculture

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H. H. BENNETT
Chief, Soil Conservation Service

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Steep slope in southwestern Ohio, contour-plowed in preparation for spring tree planting.

ANALYSIS OF TREE PLANTING PROBLEMS IN REGION 3

By G. Y. Bell ¹

DEFINITE standards for tree planting on private land are set up by the planting program of the Service. The most important problem is the selection of trees that will serve as cover to control erosion and at the same time yield other direct or indirect benefit to the individual farmer.

Tree planting is an essential feature of the soil conservation demonstration program. The very nature of the word "demonstration" demands that such plantings be successful. This is particularly true from the point of view of the farmer who may doubt that trees will grow when planted on what he considers a worn-out, worthless part of his farm. Successful planting on these poor sites requires the hardiest stock, careful thought regarding site preparation, and a thorough job in planting the trees. Planting plans must be worked out in detail because many small areas have a variety of soil conditions brought about by different degrees of erosion. Often it is necessary to use several species on an area as small as 5 acres. This is especially true if both sheet and gully erosion are present.

Several controllable factors contribute to the success or failure of an erosion-control planting. Most important are: (1) Correlation of species to soil, climate, and other components of site; (2) determination of the practical need for and method of site preparation; (3) quality of planting stock; and (4) tree planting methods, tools, and crew organization.

Site factors to be kept in mind when determining species for a planting are the original soil types and their parent materials, the degree of erosion, present physical condition of the soil, and its ability to absorb and retain moisture, extreme temperatures, and amount and annual distribution of rainfall. Often, indicator plants such as broomsedge (*Andropogon virginicus*) and poverty grass (*Danthonia spicata*) actually growing on the ground are helpful in determining what to plant.

The importance of these factors is most commonly experienced when planting black locust, probably because of the extensive use of the tree, and present indications are that the selection of planting sites for locust should be as carefully detailed as for any other species. The important point in erosion control plant-

¹ Assistant regional forester, Soil Conservation Service, Dayton, Ohio.



Mulching with broomsedge on silt loam soil in western Kentucky, center (below man). Left, area sloped but not mulched. Right, area given no treatment whatever. Trees planted, spring of 1936. Unmulched plots replanted, spring of 1937.

ings is the analysis of the site and the selection of trees or shrubs which are most practical for, first, a quick vegetative cover and, second, an economic return to the farmer.

In some locations of western Kentucky and western Tennessee, for example that area lying between the Tennessee and Mississippi rivers, only 6 to 8 inches of loess soil remain on top of old Coastal Plain gravel and sand which is cemented to various degrees. Locust makes practically no growth on these areas. Where there is 12 inches or more of loess on top of the gravel or sand, however, locust will make excellent growth on sloping or gullied land. On some sheet-eroded areas locust does not grow well, even though there may be 18 inches or more of loess on top of the gravel.

Although the soils of western Kentucky and western Tennessee are similar there is a noticeable difference in the survival of trees which have been planted in the areas. Records for 1936 and 1937 show better survival on all species for west Tennessee than for west Kentucky. This difference in survival may be due to the difference in rainfall for the two areas in the summer months. According to the United States Weather Bureau records for the past 2 years, western Kentucky had 3 to 4 inches less rainfall than western Tennessee.

In southeastern Ohio, where more rain falls in the summer months than at any other time of the year, locust makes excellent growth on both sheet-eroded and gullied Belmont and Red Upshur soils. It also grows satisfactorily on some shales, and on phases of Muskingum soils.

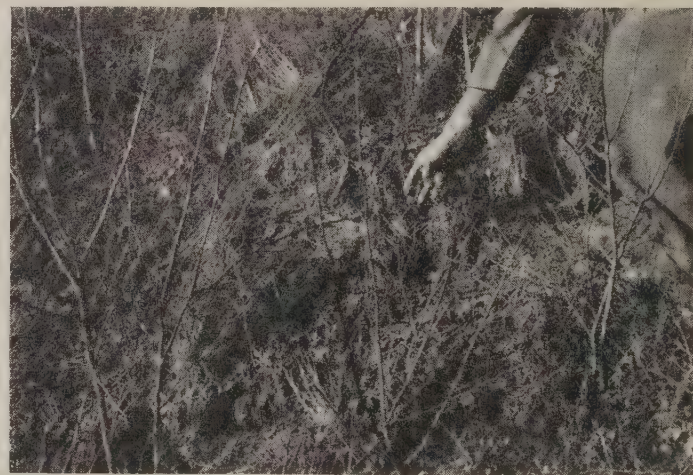
The first important question in considering site preparation is whether or not any preparation is necessary. Thus far a great deal of labor has been put into temporary gully structures as means of site preparation and a much smaller amount into contour furrows, cultivation, mulching and fertilization.

Where it appears that site preparation is necessary, practical application should be observed and the cost

figures obtained, and an analysis should be made to determine the practicability of the work and the method suitable for recommendation to the farmer.

Mulching, contour plowing, and the use of approximately 16 grams of a 2:12:6 commercial fertilizer to each tree are all practical methods which the farmer can apply himself. Computing on the basis of 1,200 trees per acre the fertilizer should not cost more than \$1 per acre. Few farmers can afford to mulch unless they have the surplus straw, hay, fodder, or manure on the farm. Any farmer should be able to plow contour furrows in the fall or winter.

Every forester in the Service knows that quality of tree planting stock is vitally important. Experience for the past several years indicates that pine stock which usually does not become fully dormant during the winter in Tennessee will die if moved into Ohio and Indiana. The planting of 2:0 white, red, Scotch and Austrian pines in Ohio and Indiana is not satisfactory because of moisture requirements and vegetative competition. Transplant stock of these species brings about better results. Better results also are obtained north of the Ohio River with 1:1 or 2:0 short-leaf and pitch pines than with 1:0 stock.



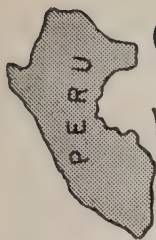
Close-up of mulched area shown in companion picture, showing cover and locust trees.

Past unhappy experiences with poor grades of locust and pine have resulted in the setting up of definite standards for grades of nursery stock to be used in the future.

Tools used in Region 3 are the grub hoe, the planting bar, and the planting mallet.

The tree planting method is an extremely important factor for the success or failure of a plantation. In turn, factors which determine the planting method depend on soil conditions and rainfall distribution.

(Continued on p. 94)



SOIL CONSERVATION IN ANCIENT PERU

By D. R. Wickes and W. C. Lowdermilk¹



THE terraces of Peru arrest the attention of the student of soil erosion. Conservationists may well ponder and study the agriculture of Peru in its development of crop plants and in the adaptation of sustained land use to steep, mountainous slopes. The value of land will have new meanings. Investments in the conservation of soils partake of an economy of survival rather than of scarcity or of abundance. And the herculean achievement of establishing a permanent agriculture or sustained use of land for cultivated crops in a forbidding mountainous area stands as one of the wonders of the world.

The beginnings of agriculture in Peru, probably some hundreds of years before the Christian era² may have been on lands recently aggraded by rivers in flood and left bare and ready for planting as water receded. However, it appears that most of the country up to the line of perpetual snow and ice was formerly occupied by forests, most of which were gradually destroyed by the inhabitants, though a few still persist.³ The forested areas were probably first cultivated by *essartage*, the *milpa* system, which is still in use in the

forested areas in the Amazon Basin. As there practiced, every 2 years a patch of ground is prepared by felling the smaller trees, leaving the larger ones standing. A great bonfire or series of bonfires is made as soon as the branches are dry enough to burn. The brushwood and tangle of creeping plants is thus destroyed, leaving the ground bare except for killed large trees. The vegetable ashes serve as fertilizer; and, after the ground is broken up with clubs, seeds or cuttings are dipped in with pointed stakes. The chief food crop is manioc (*Manihot*), though corn is much planted by some tribes. The ground will only carry two crops, and so a fresh patch must be cleared and broken up after the second harvest.⁴ Whiffen says the disused plots are never again tilled for plantation, though in Central America they may be cultivated after the lapse of many years with restoration of forests in what amounts to a long rotation.⁵

But in the temperate or higher areas the slowness with which the forest is restored after cultivation of the soil would soon necessitate other methods, particularly in the event of an increasing or even stationary population to be maintained. In the absence of effective methods to prevent it, accelerated soil erosion

(Continued on next page)

¹ Dr. Wickes is library research worker, and Dr. Lowdermilk is Chief, Division of Research, Soil Conservation Service, Washington, D. C.

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BIBLIOGRAPHY ON SOIL EROSION AND SOIL AND WATER CONSERVATION.

Compiled by Stanley H. Gaines with abstracts by Francesca Vincent, Marion Bloom, and James F. Carter. U. S. Department of Agriculture Miscellaneous Publication No. 312. Washington, D. C., in press, October 1938.

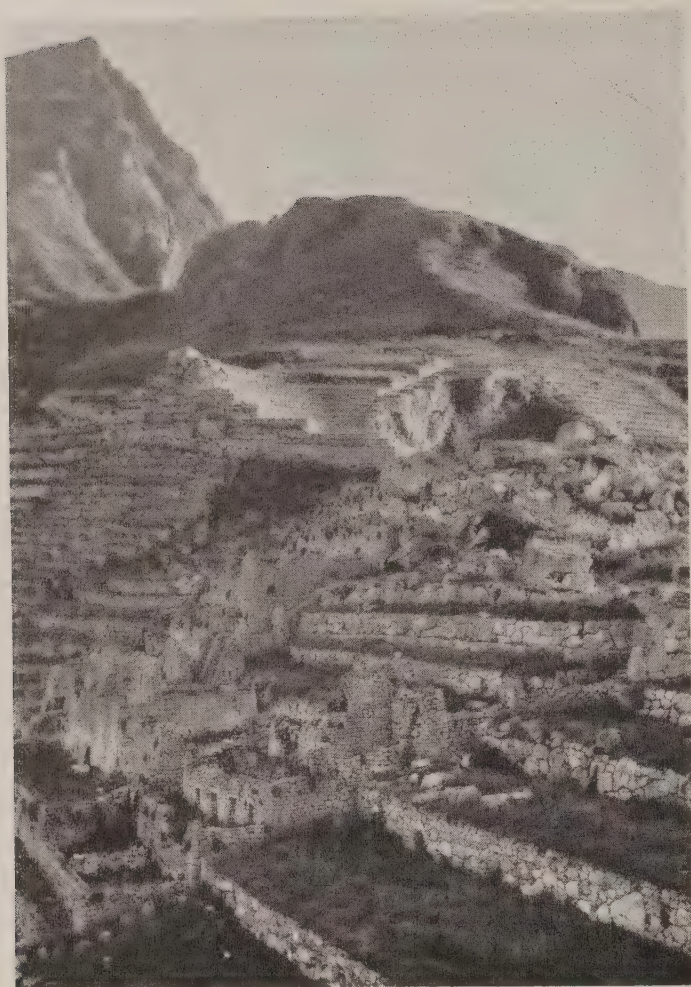
This new bibliography, the most extensive on the subject in existence, represents a year of library research and much care and thought as to organization of material on the part of the compilers. There are 4,388 items, including references to both popular and scientific writings on soil erosion and the various phases of soil and water conservation. Some citations are included which refer to the writings of various authors on farming practices and conditions from colonial times to the present, but the large majority of the references point to literature in the English language which has appeared throughout the past 30 years in the United States and foreign countries.

The organization of the material is an interesting feature. Under

the main heading "Erosion and conservation in general" are 1,164 citations, and following this is a list of 24 bibliographies, some of them extensive, which are likely to prove useful to the student looking for the available literature on all phases or any given phase of erosion and soil and water conservation. The remaining 3,200 references are divided into sections and placed under headings pointing out their relations to erosion and soil and water conservation. An alphabetical arrangement has been used for the listing of these sections—beginning with "Climate and physiography as related to soil erosion," through 18 special subject sections, and ending with "Woodlots."

A useful part of the bibliography is the List of Citations by Geographic Regions, placed conveniently at the front of the volume. The abstracts accompanying most of the citations are extremely valuable as time savers.—P. O'N. F.

Coming in November.—An article by Fred C. Newport and Robert R. Hinde, "Farming Level Terraces in the Dust Bowl."



The ruins of Machu Picchu, including the extensive irrigated terrace system. The ruins, abandoned for hundreds of years, are located in the valley of the Rio Urubamba, headwaters of the Amazon, about 50 miles northwest of Cuzco. The community constituted one of the farthest outposts of the Inca Empire in the jungles of the Amazon Valley.

would also almost certainly occur in these areas after the removal of forests and cultivation.

There is some evidence that following the removal of forests for cultivation this accelerated soil erosion actually took place. On the island of Titicaca, which was extensively cultivated in early times, the surface is described as largely covered with rocks and stones, with many boulders forming apparently an erosion pavement even in the better fields.⁶ The immense deposits of alluvium in the valley of the Urubamba and other valleys of the Sierra may well have received contributions from the accelerated erosion which would almost inevitably follow the cultivation of deforested mountain slopes. The evidence that some terraces built on the mountain sides and along stream-

⁶ Gregory, H. E. Geographical sketch of Titicaca. *Bull. Amer. Geog. Soc.* v. 45 p. 565. 1913.

⁷ Cook, O. F. Staircase farms, pp. 475, 494, 496, 497. 1916; Garcilasso de la Vega, *The Inca. First part of the royal commentaries of the Yncas*, Markham's trans., v. 2, p. 4: "the rocks were removed and earth was brought from elsewhere . . ." 1871.

beds were supplied with soil not from the slopes themselves but from elsewhere⁷ tends to confirm the belief that serious soil erosion had taken place, in some cases at least, before the terraces were constructed.

During the Inca period, approximately A. D. 1000 to 1500, laws were made for the protection of remaining forests "where they were of any importance," and their cutting was restricted to the regions where the people were in want of fuel. "It was ordained that they should be cut in due order and license, according to the requirements."⁸

Potatoes may have been the earliest cultivated crop in the temperate parts of Peru, as they are indigenous to its coast and that of Chile including the slopes of the Cordillera de La Costa and have always been a source of food to the wandering aborigines in Chile.⁹ Their culture spread very early through the uplands of Peru. They were probably cultivated there by groups who lived largely by hunting, at some time before the Christian era.¹⁰ With the domestication of the llama a more settled life would result, and this combination of herding and potato culture still persists in the basin of Lake Titicaca and other highlands where corn will not ripen on account of the low temperature. In the temperate parts where climate is less severe, corn, which was very early introduced—perhaps also before the Christian era, likely from Paraguay by way of the Gran Chaco¹¹—had practically taken the place of potatoes as an article of diet before the discovery of America by Europeans.¹²

The fertility of the alluvial soil in the valley bottoms, frequently renewed by deposits of mud from the streams in flood, must have encouraged the development of continued agriculture with crop production year after year on the same lands. The spreading of water from the streams on to land it would not otherwise reach, as was evidently done before the Inca times—probably A. D. 1000¹³—not only made it possible to raise crops during times of little or no rainfall but assisted in maintaining the fertility of the soil on those areas also. As population increased, more and more land was so irrigated, streams were narrowed and straightened by the construction of stone walls,

⁸ Polo de Ondegardo, J. *Rites and laws of the Yncas*. Ed. by C. R. Markham p. 165.

⁹ Payne, E. J. *History of the New World called America*, v. 1, p. 312. 1892.

¹⁰ Payne, E. J. op. cit. v. 1, p. 312; cf. Means, P. A. *Outline of the culture-sequence in the Andean area*. *Proceedings 19th Internat. Cong. of Americanists*, p. 237. 1915.

¹¹ Payne, E. J. op. cit. v. 1, pp. 326-329.

¹² Payne, E. J. op. cit. v. 1, p. 313.

¹³ Avila, Francisco de. *Narrative of the errors and diabolical rites in which the Indians of Huarochiri lived in ancient times*, Ed. by C. R. Markham, pp. 144-146; Means, P. A. *Biblioteca Andina, Part One*. *Trans. Conn. Acad. Arts and Sci.*, v. 29, p. 310. 1928.



A town in Peru, with terraced fields for the support of its inhabitants.

and terraces with stone retaining walls, likely used first in valley bottoms as a means of holding soil during floods, were extended farther and farther up the slopes.¹⁴ Of the work of this period, O. F. Cook says: "At altitudes between 5,000 and 11,000 feet, agriculture was of the terrace system, which the ancient Peruvians carried to a higher development than any other people. The megalithic retaining walls, built of huge rocks, unsquared, but fitted together with precision, testify to a high degree of industry, organization, and skill, and must be reckoned among the chief wonders of the ancient world. Hundreds of square miles of land were reclaimed by straightening rivers, walling, filling, leveling, and covering with a deep layer of fine soil. All of these artificial lands had also to be irrigated, often by carrying the water channels for many miles through craggy mountains or along precipitous slopes. After being cropped with maize continuously for centuries the terrace farms are still fertile, and have enabled millions of people to live in a region that in its natural condition could have been of no use for agricultural purposes."¹⁵

Dillman S. Bullock considers that all of the land which

could be irrigated was probably used by the Indians in the production of food crops before the coming of the Spanish about 1530.¹⁶ Aside from the irrigated areas, large areas higher up which received more rainfall were also cultivated with fallow periods, but a considerable part of this land appears now to have lost its fertility.¹⁷

The conquest of Peru by the Spaniards must have brought great injury to the agriculture of Peru. The conquerors sought not for foodstuffs or ordinary crops, but for treasures with which they could enrich themselves and their country beyond the sea. Accordingly, aside from the large numbers of people who perished in the wars connected with the conquest great numbers were taken from their farms to work in the mines of Potosi and elsewhere. Others were forced to work on coca plantations in a climate to which they were not adapted, with the result that large numbers died. Diseases to which they were unaccustomed, brought in by the Spaniards and spreading rapidly, such as smallpox, tuberculosis and measles, also contributed to reduce the population.¹⁸ It is generally

¹⁴ Cf. Garcilaso de la Vega, op. cit. v. 2, p. 2, 4 f.

¹⁵ Foot-plow agriculture in Peru. Smithsonian Inst. Ann. Rept., p. 487. 1918.

¹⁶ Bullock, D. S. The agricultural situation in Peru, 1923. ms., photo. 219.

¹⁷ Cook, O. F. Agriculture and native vegetation in Peru. Jour. Wash. Acad. Sci., v. 6, p. 293. 1916.

¹⁸ Popenoe, P. Proc. 19th Internat. Cong. of Americanists, 1915, p. 619; Forbes, D. Jour. Ethnol. Soc. London, v. 2, p. 198. 1870; Bingham, H. Inca land, p. 261. 1922.

agreed that during the early colonial period the population decreased enormously. Moreover, with this change of government, great irrigation works were allowed to fall into disrepair and ruin, decreasing the area which could be irrigated. Terraces in many places were abandoned and grew up to weeds or forest. The population at the time of the Spanish conquest has been stated to have been at least 10 million, some saying 20 million.¹⁹ The census of 1862 gave a total of 2,487,916 and that of 1876, 2,699,106.

Sutton names three causes or accompaniments of the retrogression of agriculture and population since the 16th century: (a) a colonial policy based on mercantilism; (b) a policy of the Republican era based upon the same doctrine, exaggerating the importance of exports and neglecting the consuming powers of the home population; (c) the applying of standardized mass production and cheap labor to an industry characterized by the law of diminishing returns and requiring the most interested intelligence on the part of the individual worker.²⁰ He considered the population in 1929 to be not much more than half that at the time of the conquest.

Much land has continued to be cultivated, however, with the addition of various crops, notably wheat and barley, and by much the same methods as were used in ancient times, though oxen for ploughing have been introduced. Moreover, in recent years population has tended to increase, so that some have gone so far as to state that the number of Indians is probably now as large as it was before the Spanish conquest.²¹ The total population was calculated by a committee of the Geographical Society of Lima to be 4,609,999 in 1896, and in 1927 it was estimated as 6,147,000. By far the larger part of the population is Indian, direct descendants of the Quechuas and Aymaras, who lived there under the Inca regime.²² Ancient irrigating systems have been repaired, and the land is again being brought under cultivation.²³

In 1925 C. W. Sutton was reported as estimating that there were approximately 1,000,000 acres (400,000 hectares) under cultivation in the coastal zone, and in the rest of the Republic a total of 1,800,000 acres (750,000 hectares) devoted almost entirely to products consumed locally (altogether, 1,150,000 hectares).²⁴

¹⁹ Ugarte, C. A. *Economic life of ancient Peru*. Reprint from *Inter-America*, v. 8, p. 129. 1924; Sutton, C. W. *Jour. Land and Pub. Utility Econ.*, v. 5, p. 372. 1929.

²⁰ *Land economics and reclamation in Peru*, p. 372. 1929.

²¹ See Bingham, H. *Inca land*, p. 261. 1922.

²² Bullock, D. S. *op. cit.*, p. 8; Milstead, H. P. *Distribution of crops in Peru*. *Economic Geog.* v. 4, p. 88. 1928.

²³ Bullock, D. S. *op. cit.*, photo. 219; Bingham, H. *In the wonderland of Peru*. *Nat. Geog. Mag.*, v. 24, p. 490. 1913.

²⁴ Dunn, W. E. *Peru, a commercial and industrial handbook*, p. 98. 1925.

The figures published by the Ministry of Agriculture for 1929 gave the total cultivated area for the Republic as 1,463,867 hectares. Of crops, potatoes have the largest area, 285,274 hectares; and corn comes a close second with 280,412 hectares. Wheat has 142,154 hectares, and barley 124,806 hectares, cotton 126,883 hectares. No other crop approaches 100,000 hectares, though sugar has 77,987 hectares.

Thus, without iron implements, wheels or draft animals, without a knowledge of chemistry or of writing, the ancient Peruvians developed an agriculture which persisted through hundreds of years, mastered soil erosion, and is still continuing, with slight change, over considerable areas. In the domestication of potatoes they conferred a great benefit on the human race. They have left a remarkable example of success along with one of partial failure, in the cultivation of sloping lands. The failure appears to have occurred on lands not irrigated which became exhausted of certain plant foods essential to the production of crops. For intelligent industry, for solving problems in land use which we have not yet the temerity (or need) to undertake, for preventing soil erosion, and for the conservation of soil and water, the ancient inhabitants of Peru must be acknowledged as the first soil conservationists of the New World.

ANALYSIS OF TREE PLANTING PROBLEMS IN REGION 3

(Continued from p. 90)

The actual planting of the tree is the keystone of the entire program. Even though every step is correct to this point, improper planting of the trees may result in a plantation failure.

Certain points on how to plant a tree should be drilled into every individual tree planter during his first few days on the job. Failure to learn these essentials at the start may cause poor survival, poor growth, and sometimes the death of the trees several years later. Briefly these vital points are: (1) Depth to which the trees are set in the ground, (2) position of the tree roots in the ground, (3) condition of the soil placed around the trees, and (4) position of the tree after planting. Allotted space does not permit me to describe in detail the different methods of planting used in the attempt to place the trees in the ground in the most favorable condition for survival and growth. Every forester knows what these conditions are; the problem is to teach, to train, and to organize the men who do the work so that these conditions will be brought about.

TERRACES INCREASE YIELDS IN THE PLAINS

By Fred S. Reynolds¹ and Albert E. Coldwell²

MANY people have an idea that the Great Plains are practically level and do not need terracing for crop production. The fact should be borne in mind that water is the limiting factor in crop production on the Plains, that thousands of wet-weather lakes dot the countryside, and that these lakes receive their water from adjacent "level" land during rains. For clarification of this erroneous idea a survey was made on the Dalhart, Tex., project to determine yields and to measure the effectiveness of terracing and contouring in the area. A secondary objective of the survey was a comparison of the erosion-control value of vegetative covers found on the fields.

Yields of headed grain sorghums, for the 1937 crop year, were obtained on 63 fields. These included some fields that were under cooperation and others that were not. The height, density and kind of crop were recorded. Yields were obtained on 11,485 acres by taking 3,099 samples—1 to every 3.7 acres. The tables show results of the yield survey. The number of farms and acres are given for all comparisons. The larger the number of farms and the greater the acreage the more valuable the results obtained. The terraced fields in this study averaged one-half of 1 per cent slope. None was greater than 1½ percent.

Table showing yields of headed grain sorghum on terraced, contoured, and straight-row fields on all except fields with sandy-type soils

Treatment	Number of fields	Acres	Average yields per acre
			Pounds
Terraced.....	20	4,226	720
Contoured.....	21	4,035	589
Straight rows.....	7	882	461

Comparison of the yields on terraced, contoured and straight-row fields clearly shows the advantage of terracing. The fact that 20 fields with 4,226 acres of terraced land averaged 723 pounds as compared to only 589 pounds for 21 fields of 4,035 acres of contoured land is a strong justification for terraces. The data on straight rows are limited to 7 farms of 882 acres with a yield of 461 pounds, which is still more convincing as to the advantage of terracing. Those who made the survey are of the opinion that the comparative relationship between the terraced, contoured, and straight-row fields would not have changed mate-

rially even if a much larger number of straight-row fields had been included.

Field observations showed that all the soils except the deep sandy types lost large quantities of water where contoured as well as where farmed straight. In contrast, terraced fields held and absorbed all the rainfall, and in numerous cases caught floodwater from adjacent areas to augment the rainfall. An excellent example of this is a terraced quarter-section of milo yielding 1,149 pounds per acre, which was flooded in May by run-off from adjacent fields. The four adjacent fields comprising 730 acres (two contoured and two with straight rows) produced from 236 to 506 pounds per acre, with an average of 307 pounds. All have the same soil type, received the same rainfall, and were farmed in a similar manner. The only factor of importance contributing to the high yield of 1,149 pounds was the terraces. Other terraced fields surrounded by unterraced ones showed similar results.

The straight-row fields, sandy soils excepted, were conspicuous by the spotted condition of their crops. The low spots where water pooled produced heavily, while the balance of the field was a near failure in most cases. On the other hand, terraced fields were remarkably uniform throughout, with the exception that the areas just above the terrace ridges were generally better than that below.

Table showing yields of headed grain sorghum on land terraced 1 year, compared with that terraced 2 years or more; including all soils except sandy types

Treatment	Number of fields	Acres	Average yields per acre
			Pounds
Terraced 1 year.....	6	1,696	656
Terraced 2 years or more.....	14	2,530	768

Since no moisture determinations were made over the terraced area, the probable reason for the difference in yields cannot be definitely ascertained. It is believed, however, that both the accumulation of soil moisture from year to year and the closer spacing of terraces contributed to the higher yield on the older terraces.

Those making the yield survey are firmly convinced of the advantages of terracing. It is our opinion that contouring is only a partial step in the right direction and that terracing should be vigorously pushed on all the soil types except sandy soils.

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Poor Man's Cow



By
Lois
Olson

An ancient
Greek vase.

THROUGHOUT Europe, conservationists from the Middle Ages to the present have regarded the goat as Public Enemy No. 1. No vegetation can escape the ravages of its sharp teeth and prehensile tongue; and its hoofs form beaten tracks, where runoff concentrates, or cut the vegetation and expose the soil to erosion. But, in spite of this, no other animal has been found that can replace the goat in the domestic economy of "the poor man." Three or four goats will supply as much milk as the average cow, and can be fed on half the cow's rations. A single cow supplies milk for only a portion of the year but with a few goats a farmer can maintain a constant milk supply for his family.

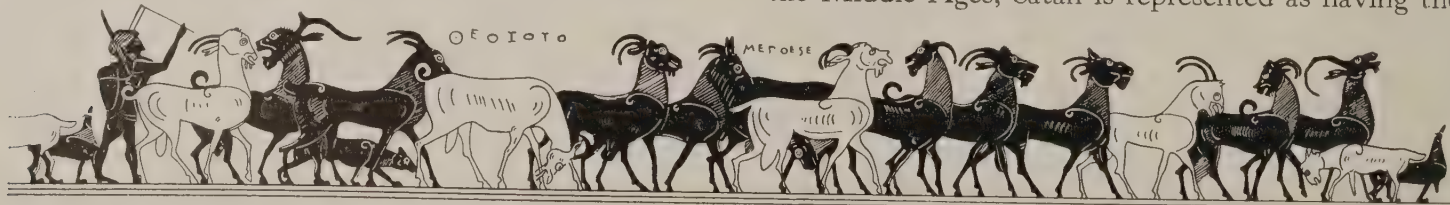
Nor is the goat merely a milk producer. Although goat meat is unpalatable, that of the kid rivals very young lamb in quality and the skin and wool of the goat have clothed the inhabitants of the semiarid lands since the dawn of history. Among the ancient Egyptians goat's wool was considered choice enough to be woven in mixture with silk and fine linen; and when the Israelites were returning from their exile in Egypt, their altar cloths and the curtains for the tent that housed the tabernacle were woven of goat's wool. Usually, however, the fleece of a goat consists of a mixture of hair and wool and, unless the two are separated, it can be used only for coarse fabrics, such as tenting, or for ropes and cables.

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There is no record of the first domestication of the goat, but Central Asia is commonly regarded as its original home. When history began, they were well distributed over the known world. The kitchen-middens of the Swiss lake dwellers contain the bones of domesticated goats, and cuneiform records show that they were known to the Assyrians and Persians before 3000 B. C. Goats were found wild throughout the European highlands, and prior to the fourteenth century they were more common than sheep in the Scandinavian countries and the British Isles. Africa also abounds in goats, but the wild species are considerably smaller than those of Asia.

Goats were numbered among the riches of the Egyptians and, according to tomb records, one owner boasted the possession of 2,234 goats. Egyptian paintings depict herds being driven across newly sown fields to tread the seeds into the ground. So great was the prestige of the goat that, during the Second Dynasty, it was deified. Among the Hebrews the goat was a sacrificial animal, and the laws of Moses proclaimed its flesh "clean," and it could be used as human food. Rams, being aggressive animals, were selected to lead the flocks. In this connection the term "goat" or "he-goat" is used figuratively in the Bible to denote a "prince"—"Mine anger was kindled against the shepherds, and I punished the goats." (Zachariah X, 3.) In India the epithet *aja*, meaning "he-goat," was bestowed on certain deities, such as Brahma or Vishnu. The Libyan Jupiter had the horns of a ram and the Grecian Jupiter and Minerva are represented as wearing goat skins for their breastplates.

Pan was the goat-god of the Romans. He presided over shepherds and their flocks. But Pan gradually became confused with fauns and satyrs and changed his character from the beneficent to the malign. His mischievous pranks caused sudden fright among the country folk, and from this we derive the English word "panic." During the early Christian era Pan-like pranks were ascribed to the devil, and throughout the Middle Ages, Satan is represented as having the



cloven hoof of the goat. The significance of the cloven hoof continues—for the goat does “play the devil” with the land.

As long as the goat remains “the poor man’s cow,” the damage that it causes is almost negligible because the farmer with only a few goats seldom allows them to roam and graze promiscuously. The real danger develops when goats become a staple food supply, replace agriculture, or serve in lieu of currency. The Jews, who lacked means of refrigeration, were forced to rely on the smaller animals for their food supply. The fatted calf was killed only on special occasions, when the entire animal could be consumed at a single feast. The brother of the prodigal son complained that not even a kid had been killed in his honor. The effects of the ever-present goat are reflected in the eroded and treeless hills of Palestine, where once-famous forests are known to have existed.

During the Age of Pericles, Greece was at the height of her glory; but thereafter agriculture declined, and grazing, particularly of goats, increased. A large proportion of the forests had been cut down to build the navies that controlled the Mediterranean, farming had spread up the mountain slopes, and serious erosion was in progress. After rains, the run-off from the hills was rapid and the floods became higher and more frequent. The channels were blocked with sediment and the rivers, instead of flowing directly to the sea, overflowed the lowlands and covered them with debris washed from the hills or converted them into marshes. Much of the agricultural land could no longer produce crops at a profit and the farming population turned to grazing as a means of livelihood. Since Greece is mountainous, and since vegetation is sparse during the summer droughts, sheep and goats predominated. Goats are better climbers than sheep and can exist on a more meager food supply; where grass is lacking they browse on scrub vegetation, seedling trees, or even bark. As the pastures of Greece became poorer because of overgrazing, erosion became more widespread and the tendency to raise goats instead of sheep increased. In Greece the goats completed the task of forest destruction and their omnivorous appetites prevented forest regeneration.

The anopheles mosquito and the goat have always been allies. In Greece the goat increased erosion and run-off, and so indirectly provided the mosquito with more extensive swampland in which to breed. From

the writings of Hesiod it seems probable that epidemics of malaria occurred in Greece as early as the Eighth century, B. C., but it did not become endemic until four centuries later—at the time of the shift from agriculture to grazing. According to Plutarch, the death of Pericles himself was caused by malaria. One by one the Greek states fell heir to malaria—even Boeotia, which had been renowned for its salubrious climate. Today, malaria is endemic throughout Greece and the hillsides support more goats than people.

Much the same story is repeated from Jerusalem to Madrid: “Forests given up to sheep and goats; forests destroyed, mountains devoid of life.” In Cyprus, sheep and goats have almost replaced cattle, and the control of goat grazing in the forests has been one of the major problems of the British Government since its occupation of the island.¹ The importation of goats was prohibited by the forest law of 1881, and in 1913 a “goat law” was passed which enabled villages to decide by vote whether or not goats should be allowed within the village limits. In general, agriculture, particularly fruit growing, has improved greatly in exclusion villages. From 1914 to 1918 the problem of grazing was neglected, and all possible effort was directed toward the securing of wool in sufficient quantity to meet the requirements of the war. When efforts to restrict grazing were revived, and when applications for grazing rights were legitimately denied, protests and incendiary fires followed. It has generally been assumed that goatherds were poor men with no other means of earning a living if they were deprived of the use of the forests, but according to Unwin they are as a rule in better financial position than the average Cypriot peasant. Efforts are now being made to reduce the number of goats by giving their owners land with fruit trees, huts, and tools in exchange for goats. To date, however, the most effective method of reducing the number of goats has been through starvation resulting from the exhaustion of the pastures.



¹ Unwin, A. H. *Goat grazing and forestry in Cyprus*. London, 1928.

Italy and Spain also have large goat populations living on badly eroded pastures. In Italy it is recognized that the goat is an index of poverty, and recent legislation has levied taxes on goats in order to reduce their numbers and so end "la morte della montagna." To preclude unnecessary hardship, the poor farmer with only a few goats is exempt from taxation. Without restriction on goats it would be impossible for the Italian government to succeed in its campaign for the reforestation of critical mountain slopes. Regnault² attributes the serious overgrazing and erosion in Spain to the decline in population following the discovery of the New World and the consequent shift from farming to grazing. The flocks that were pastured in the lowland in summer and the plateaus in winter were everywhere granted the right of way during their migrations, and fences were prohibited. Rivers were turned into seasonal torrents and in Andalusia, as in Greece, malaria became endemic. Today the grazing of goats in the Spanish forests is prohibited, but the laws are commonly ignored.

Northern Europe began a war on goats centuries ago, and today the problem of goat grazing is almost negligible in most areas. Grazing in the forests is an integral part of the traditional forest rights or servitudes which originally developed to provide for the domestic requirements of the local population—but not for business purposes. As early as 1435, sheep and goat grazing was prohibited in the forests of the canton of Freiburg, and during the sixteenth and seventeenth centuries, most of the Swiss cantons forbade the grazing of goats in coppice stands of a minimum age, ranging from 5 to 12 years. According to a decree of the King, the royal forest of France was closed to sheep and goats in 1515, but the decree was never effectively enforced. The ordinance of 1669, passed during the reign of Louis XIV, limited the grazing rights of sheep and goats and similar restrictions were contained in the Code Forestière of 1827, but in the Alps and the Pyrenees any type of restriction met with open hostility. It has been estimated that within historic times the timber line in some parts of the Alps has been lowered 1,000 feet by overgrazing. In the various German states goat grazing was restricted by the earliest forest ordinances, but the problem was never as serious as in France and Switzerland.

Nowhere in Europe has the destruction caused by goats been as spectacular as on the Island of St. Helena. Goats were introduced in 1502 and multiplied rapidly.

At first the overgrazing of the forest escaped notice because the goats fed on the young trees. The cumulative effects appeared suddenly when the older trees reached the age at which they normally died. In 1710 there were still good forest stands, but by 1724 most of the old trees had fallen and were replaced not by other trees but by grassland. Over a hundred years later (1836) Darwin commented, "Sandy Bay is nowadays so arid that it was necessary for me to see an official record to believe that trees had ever grown there."

In Africa there is less justification than in Europe for the continued existence of the huge herds of goats that destroy the vegetation and expose the land to erosion. Their meat is eaten by the natives only on ceremonial occasions and these have decreased in number since the introduction of Christianity. The milk is used only as food for children, and the skins are of such poor quality that they are seldom worth more than 6 or 8 cents apiece. Among the native tribes goats serve chiefly as a measure of wealth and for the purchase of wives to ensure to the head of the family sufficient progeny to maintain his prestige in perpetuity.

When land is first cleared it is used for cultivated crops with little thought of either maintaining the fertility or precluding soil erosion. After a few years of cultivation crops are no longer possible and the land is turned over to cattle. Much of the erosion caused by cattle is the result of inadequate water supplies. Cattle trails are formed leading to the watering places and around them the soil is badly trampled and the vegetation destroyed. As the land becomes too poor to support cattle it is turned over to goats who finish the process of destruction, and when they pass on to better pastures they leave behind a complete desert. When the ground has been bared, the goats reach upward for their food, and by standing on their hind legs can browse to heights of 5 or 6 feet. Near Lake Baring, in Kenya, Champion³ noticed a line, like a flood line, some 5 feet from the ground, below which no green vegetation had survived. Unlike a flood line it undulated with the surface of the land; it represented the upward limit of goat grazing.

On foreign estates in East Africa the introduction of methods for controlling erosion is progressing rapidly, particularly in the English colonies and mandates. Crop rotation and mixed farming are common practices, the dairy industry is developing, efforts are being made to limit the stock to the carrying capacity of the pastures, and to some extent rotation grazing has been

² Regnault, Felix. The rate of depopulation, deforestation, and malaria in the decadence of certain nations. Smithsonian Institution Annual Report, 1914. Washington, 1915. pp. 593-597.

³ Champion, A. M. Soil Erosion in Africa, Geographical Journal. 82: 120-129. August 1933.

adopted. Government subsidies and loans have also made possible an increased use of terraces and contour furrowing and the construction of erosion-control works.

The education of the natives is of necessity slower, but farming in general is improving under European guidance. But grazing is so ingrained in native tradition that no methods of curtailing it have been completely successful. To a large extent the erosion caused by native agricultural and pastoral pursuits has resulted from the establishment of the "Pax Britannica." In the past the number of the inhabitants and the size of their herds were limited by the ravages of warfare and disease. With this restraint removed both have increased rapidly in number and the land has suffered from overpopulation and overgrazing.

In South Africa, Angora goats have been introduced in the hope of improving the native strain and placing goat raising on an economic basis. Effort is also being made throughout East Africa to limit grazing by increasing the agricultural area. Although partially successful, it has been found in some areas that herdsmen have overgrazed the remaining pastures rather than part from their precious goats. Similarly, the sale of goats often has merely shifted the problem of overgrazing by increasing the size of the flocks in other areas. Cattle, even of inferior stock, can be used for meat extract, but not so with goats. If the quality and the value of goatskins can be improved, sale might

prove effective, provided that the natives can be converted to the idea of wealth in the form of currency and savings accounts rather than of animals. Until this can be accomplished, efforts must be directed to the education of the natives and the improvement of pastures by regrassing, selective grazing, provision of more numerous watering places, reduction of burning, and the production of supplemental fodder supplies.

Since the Abyssinian War English writers have been much concerned about the effect on Egypt of the Italian ownership of Lake Tana, at the headwaters of the Blue Nile. Recently Newhouse⁴ has suggested a more serious problem. "If Abyssinia becomes quiet and peaceful, and cattle and goats increase, the countryside will be torn to bits by torrents, the discharge of the Blue Nile will be a monstrous flood every year, and its whole regime altered to the certain detriment and possible ruin of Egypt." Unwin⁵ struck a similar note in discussing the problem of overgrazing in Australia: "One cannot conjecture, without apprehension, what the result would have been had thousands of goats [rather than sheep] been allowed to graze * * *." It would most certainly have resulted in tragedy. And may it here be noted that the word "tragedy" is derived from the Greek word "tragos," meaning a goat's skin, which was the garb worn by the actors in the Greek Tragedies.

⁴ Newhouse, F. Preservation of the Nile. The Engineer. 164: 624-625. 1937.

⁵ Op. cit., p. 56

WOODY VEGETATION FOR FENCE ROWS

By Frank C. Edminster¹

GENERALLY speaking, open land planted to farm crops or in pastures provides inferior habitat for the majority of wildlife species in the Northeast. This is particularly true of sedentary forms, including all farm game birds. While a few songbird species may find all their requirements within a single field, most birds and the larger mammals need a diversification of cover types in their seasonal habitats and a variety of habitat types in their year-round territory. It is true that variety in crops grown on a farm provides changes in habitat and that the margins are "edges" of a sort and are especially valuable when fields are strip cropped; but by and large, farm fields lack year-long shelter and are not secure in the major habitat attributes. Mowing, harvesting, grazing, or plowing will eventually remove most of the livelihood sources of the wildlife inhabitants.



Acting as a windbreak and snow fence, interfield cover conserves soil moisture and reduces wind erosion.

Woody vegetation of one type or another, and swales and swamps, are the major types of permanent shelter found on farms in the Northeast. Properly distributed through the farmed land, they greatly enhance carrying capacity for most forms of farm wildlife. With "clean" farming and the utilization of all possible acres for crops, however, these shelter areas are generally not well distributed, because they are confined to land not farmable because of physiographic conditions. Or,

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This contour fence overgrown with elderberry trees and blackberry bushes serves as a barrier to water erosion. The ground level on the upper side is 6 feet higher than that on the lower side.

we may say, as croplands are generally in contiguous fields, extensive acreages are devoid of adequate protective cover. This condition reaches its extreme development on the more fertile and high-land-value farms and is progressively less marked on farms that approach the submarginal class.

Considering the possibilities of remedying the deficiency in wildlife shelter, we must accept the basic premise that although cropping methods may be changed, as from block fields to strip-cropped fields, lands now being farmed must continue to be cropped substantially as in the past. The one big opportunity for the creation of permanent shelter areas on cropped land lies in the revegetation of permanent field boundaries—the fence rows.

Fashion as much as anything has led farmers to subscribe to the dictum of clean farming—that is, bare fences and avoidance of weedy and shrubby vegetation. Based on the principle that such growth harbors pests inimical to crops, the practice of clean farming has also become a criterion of neatness. That the practice is detrimental to wildlife has not lessened its use.

Actually, overgrown fence rows, except where they contain alternate hosts of crop pests, are of benefit rather than detriment to crops. There are several reasons for this: They encourage birds which feed on insects and the seeds of weeds, and this assists in pest control; they act as barriers to soil erosion; they form windbreaks for the protection of crops and soil. In many instances, also, they furnish additional farm crops, such as berries and fence posts.

The problem is largely one of education. When it becomes stylish to have a dogwood hedge instead

of a bare wire fence, there will be a dogwood hedge. When it is considered good farming practice to allow fences to overgrow, a man will be judged a good farmer when he does so. When the farmer has been shown the correct economics of brushy fences, it should not be difficult to change his aesthetic viewpoint. A fence row with foliage, flowers, and fruit certainly makes a more pleasing picture than does a stretch of galvanized wire. Other nations have learned the worth of such fences; Americans also should be awakened to an appreciation of a beautiful farm landscape.

I have indicated, in a general way, that the presence or absence of brushy fences determines to a considerable extent the wildlife population of the farm. Obviously this is true only in proportion to the extent and distribution of other permanent wildlife shelter habitat. The need for brushy fences, as far as wildlife is concerned, is primarily on farm lands that lack adequate woods, swales, and swamplands that are well distributed.

As a rule, fences will acquire a woody vegetation naturally where close cropping and cutting are avoided. For quicker results and to ensure the desired species composition, however, it is often desirable that fences be planted. This is particularly true of fences that lie on or approximately on the contour, and on land that needs soil-erosion control.

In choosing species of woody vegetation for fence-row planting, several factors should be considered. A brief outline of them is given below.

(1) Species which are tolerant of crowding, which form dense thickets and which have soil-holding root systems are desirable. Stoloniferous species are particularly adaptable in this respect.

(2) Species of low height growth, from 3 to 10 feet, are generally preferable to trees. Conifers are an exception, since they may be topped for Christmas trees when large enough.

(3) Species should be included that will furnish shelter to wildlife throughout the year.

(4) Species that will assure food for wildlife at all seasons should be given preference.

(5) Species furnishing fruit, nut and wood products for human use may be included where these are desired.

(6) Species resistant to grazing should be used on fences bordering pastures.

(7) Alternate hosts of crop pests should be avoided. In the Northeast these include red cedar, common barberry, gooseberries, currants, and buckthorn.

(8) Species poisonous to humans or livestock should be used with caution, or avoided entirely.

(9) Species selected should be adapted to existing conditions of soil and moisture, and should be light-tolerant.

(10) Native species are generally preferable to introductions from other regions, or exotics.

(11) The expense of close planting may be obviated by using species that reproduce quickly.

(12) Ideally, at least three types should be planted in each fence-row; one thicket-forming hardwood shrub, one vine, and one evergreen.

Brushy field fences are a means of conserving soil especially when they run across the slope. A recent (December 12, 1937) radio Farm Flash, issued by the Office of Information of the Department of Agriculture, cites a specific case illustrating this point. Referring to a farm in Kansas, it states that "like many other fields in the vicinity, [the] land was damaged by wind and erosion and the blowing soil piled up in drifts along the fence. Last year [the owner] observed that run-off water from his field backed up behind a large fence-row drift.

"This year his wheat yield ran 10 bushels more per acre on that part of the field where water was held by the drift. The fence-row drift had served as a terrace to hold water on his field where it could seep into the soil for plant growth."

This same principle applies to farms in the East, where water erosion is the main cause of soil losses. Cross-slope fences that are overgrown serve as barriers to both sheet and gully erosion and tend to form a terrace, which improves soil moisture conditions. In numerous cases there has been observed a 3- to 8-foot difference in ground level above and below the fence, largely owing to the building up of washed soil on the upper side of the fence.

The soil-conserving values of hedge fences have a

direct bearing on wildlife since, like any other crop, it is basically dependent upon the soil. But the important aspect of the fence-row soil relationship to the wildlife manager and soil conservationist is that a sound program of farm wildlife management can be presented on a multiple-purpose basis. The direct agricultural benefits accruing from field hedges are more readily appreciated by the farmer than is the wildlife value alone. The encouragement of between-field permanent cover should be made on its complete multiple-value basis.

We have so far considered the farm fence as a means of obtaining permanent cover for wildlife on open lands and of improving soil conditions for farm crops. We may add that it also protects woodlands, swales, swamps, and water areas from livestock grazing. The effect of grazing on such wildlife habitats is too well known to need elaboration here. Too often, grazing renders uninhabitable to many species an area with great wildlife potentialities.

It should be noted that, contrary to open-land fences in relation to wildlife, the value of the fence in protecting woodland coverts tends to increase with the less fertile and poorer farm lands. Here, again, the arguments against the practice of grazing these inferior pastures are not confined to the advantages of encouraging farm wildlife. A sustained yield of woody products demands that woodland reproduction be protected. Proper conservation of farm soils and water is impossible without protected permanent vegetation in woodlands, gullies, swamp, and marsh areas. The wildlife program must be constructed on this multiple-purpose foundation if it is to be practical and successful, and the use of the fence as a tool of the conservationist should be given greater attention than ever before.

EROSION PROBLEM CONFRONTS HAWAII

By N. E. Winters ¹

SINCE the voluntary annexation in 1898 of the Hawaiian Islands to the United States they have developed rapidly in industry, agriculture, and commerce. Our largest army post under one command is located on the Island of Oahu about 22 miles from Honolulu, a modern city of nearly 150,000 inhabitants.

When the English explorer, Capt. James Cook, discovered the Hawaiian Islands in 1778, he found them inhabited by approximately 400,000 Polynesians. They were happy and carefree, needing only grass

huts for shelter and grass skirts for clothing. They lived by fishing and a very primitive form of agriculture. Under a balanced diet of fish, breadfruit, taro, nuts, and fruits, they were a good natured race of wonderful physique. Like the American Indians, the Hawaiians had difficulty in adjusting themselves to changes in the social and economic order brought about by the coming of the white man. They had a strong disinclination to hard manual labor, so that the planters found it necessary to import laborers from various countries.

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Abandoned pineapple field in Oahu south of Schofield barracks. Most of the soil is gone from this field.

Between 1852 and the annexation to the United States, laborers were imported from China, Japan, Puerto Rico, Philippine Islands, Norway, and the United States. Most of the unskilled laborers came in under contract to work for a period of years at stipulated wages and hours.

The first missionaries from New England landed near the Kona Inn on the Island of Hawaii in 1820 and several boatloads followed during the next 40 years. The entire life, including agricultural and social development of Hawaii, has been profoundly affected by these sturdy pioneers and their descendents who are now among the principal financial, agricultural, industrial, and educational leaders of the Territory.

Of the present 400,000 population only about 6 percent are pure Polynesian and 8 percent are mixtures of the Polynesian blood with whites and other races. Approximately 22 percent belong to the white race and some 55 percent are Orientals. There is an average of 57 people per square mile, the population



Wailua Falls, eastern slope of Kauai.

being very unevenly distributed. Thirty-seven percent of the people live in Honolulu. Hundreds of square miles in the mountainous sections are uninhabited, while the rich agricultural sections are densely populated.

The first sugarcane plantation was established at Koloa on the Island of Kauai in 1835. Before these plantations got under way most of the farming operations were conducted on a small scale, but during the last 50 years large sugarcane plantations have demonstrated their ability to cope with the problems of production and marketing and to give better returns on investments than did small farms working independently. At present 39 sugar-producing corporations operate under the direction of 6 cooperating agencies who are members of the Hawaiian Sugar Planters Association. The association founded an experiment station in 1895 and now has a staff of 100



View of erosion in Hoolehua pasture of Hawaiian Homes Commission.

scientists and an annual research budget of half a million dollars.

Since 1900 the pineapple industry has attained stabilized production and marketing by means of large companies working in cooperation under the corporation known as the Pineapple Producers' Cooperative Association, Ltd. This industry employs about 25,000 people in the Territory. The pineapple producers also have a well-organized experiment station. Through this corporation, agricultural and industrial leaders in Hawaii have developed a high degree of efficiency in the production and marketing of both sugar and pineapples. The annual revenue from these two crops approximates \$150,000,000.

Erosion is not so general and widespread in the Territory as it is on the continental United States. The geologic youth of the islands, and the tendency



Incipient gully formation on pasture land of Lanai with clumps of Natal grass.

toward a lateritic soil development over basaltic volcanic lava rock, cinders, and ash, has resulted in rather permeable soil and rock conditions which are more or less resistant to erosion, especially in the areas of heavy rainfall. Over 70 percent of the cultivated land produces sugarcane which, when well established, is a good erosion-resistant crop.

The most serious erosion is found in clean-cultivated fields where pineapples and other row crops are produced. Approximately 22 percent of the cultivated area produces pineapples and about 6 percent produces

other crops, most of which are not resistant to erosion. Some 25,000 acres are plowed and fallowed each year in preparation for planting sugarcane. During this period of preparation and before the young cane becomes well established, especially on steep slopes, large quantities of soil may be washed from the fields by the heavy rains which are characteristic of the Territory.

Incalculable losses of soil from both wind and water erosion have occurred on pasture and range lands where grasses have been destroyed by overgrazing, and where the original valuable forests have disappeared under exploitation.

The progress of civilization during the last 150 years has in many parts of the islands had an effect similar, in the exploitation and destruction of the great natural resources of soil, range grasses, and forests, to that found on the mainland.

The Territory of Hawaii is in the hands of capable and intelligent leaders who have watched the clouds of dust as they blow out into the Pacific. After heavy rains, they see their precious soil washed down to fill up their fishponds with erosion debris and to darken the waters of the ocean. These leaders are fully awake to the menace of erosion and are ready to cooperate in a control program of well-planned and practical research and field operations.

STRIP cropping, an accepted practice in areas of high rainfall, likewise has established its value in controlling wind and water erosion in the semiarid Great Plains region.

Twenty-six demonstration project and camp areas and nine conservation districts in Region 6 reported a total of 91,909 acres of strip crops in 1937. Included were cotton, corn, beans, summer fallow stripped with sorghums, and small grains.

Soil blowing became serious in the central part of the Great Plains area 5 or 6 years ago. It is assumed that drifting will remain a problem as long as a summer fallow system prevails.

Depletion of crop residues and trash because of drought and resultant wheat failures has convinced farmers that they must change their methods to produce profitable yields. This realization has led to emergency measures which are inexpensive and otherwise practical. Many farmers have turned away from summer fallowing and wheat growing and are now planting their fields solid to sorghums in order to regain residues or trash for stabilization of the soils.

In 1936, farmers who had grown good grain and forage sorghum crops the previous year were prepared

Dust-Bowl Experience with Strip Cropping

By R. R. Hinde¹

to start strip cropping. In the Dust Bowl, however, there was little experience or experimental data on which to start a strip-crop program. Ideas varied as to width of strips. Patterns ran from alternate plantings of 2 to 68 rows of sorghums for protection of fallow spaces as wide as 200 feet.

In areas of straight grain farming a practice now proved to be effective consists of alternating summer fallow and grain in strips of equal width. Where the land is fallowed every third year instead of every second year, grain strips are made twice the width of the fallow. Width of strips are regulated to suit

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available farm machinery, but are kept on the contour.

A farming system which is becoming popular in western Kansas and eastern Colorado is the sorghum-fallow-wheat combination. In this, sorghum is rotated in the strip one year, followed by fallow the next, then wheat. Fallow, coming immediately after the sorghum, reduces the wind erosion hazard usually present when fallow follows wheat because sorghums supply the soil with adequate residues.

Width of sorghum strips depends upon the farmer's forage needs, but as a general rule a field is divided to a third each of sorghums, fallow, and wheat. This cropping system better balances farming operations, provides diversification and includes the yearly production of livestock feed.

This system enables the farmer to know each year the acreage he will have in crops and in fallow. Flexible or variable cropping is possible. For example, if moisture and residues are favorable in the fallow strips at planting time, wheat may be seeded. If conditions are favorable for such planting, fallowing should be omitted, with sorghums being planted solid at the first opportunity the following spring.

Strip cropping of fallow is subject to certain precautions. The surface soil ought to have ample residues or trash which can be conserved by cultivation. Certain tillage implements used for seedbed preparations encourage soil blowing more than others, especially during summer cultivation. Preferably, plowing and other cultural operations should be done only when the soil is moist. A cloddy surface breaks the ground sweep of winds and reduces soil drifting. Implements should be selected according to their efficacy in producing clods and incorporating crop residues in the surface layer.

In most of the Dust Bowl, with the exception of certain parts of Colorado, eroding winds come from various directions. Contour operations, therefore, are for reducing water run-off.

Border plantings at the edge of a field fit well into the strip-crop system. They furnish double protection to crops by retarding run-off water and by checking the spread of soil drifting from adjacent unprotected areas.

Such border plantings usually are seeded with a grain drill or broadcast seeder. The strips should be wide enough to permit the turning of implements and to prevent plowing or cultivating into the terrace outlets.

There is little experimental data on which to base the width and frequency of strips used for wind and water erosion control on any given slope, soil type or field subject to erosional losses. The width of erosion-

resistant strips in relation to the width of erosion-resistant crops is determined by the erodibility of the soil, wind velocities, slope, and character of rainfall. For these reasons, it is recommended that about one-half of the field area be planted in strips to an erosion-resistant crop. Densely-growing feed crops such as sorghums, small grains and cultivated grasses are of proved usefulness for these control strips.

In the High Plains area strip cropping, plus terracing, is believed to be even more effective than strip cropping alone. This is because terraces increase favorable planting opportunities through conservation of run-off water.

Strip cropping alone is not enough. It is a practice which fits naturally into a variable cropping system with contour tillage operations and cultivation along the terraces. Observations in the Dust Bowl indicate that erosion-nonresistant crops such as corn, beans, and potatoes should be planted in strips of 4, 8, 10, or 16 rows, alternating with strips of sorghum or small grain of as many or more rows. Cotton, when grown on the lighter textured soils, should be planted in strips of from 20 to 30 rows, alternated with sorghum in strips of not less than 10 to 15 rows. On heavier textured soils, strips of cotton may be as great as 40 rows in width, alternated with strips of sorghum of 15 to 20 rows.

Observations show that varying heights of stubble play an important part in reducing soil blowing. There are several forms of soil movement. Among them is the dust cloud of very fine particles which rise to great heights and are carried long distances by air currents. Another is the stratum of heavier particles billowing along 5 to 10 feet above the ground. These particles settle rapidly as the wind velocity diminishes. A third important type of soil movement involves larger particles swept along not more than a foot or two above the ground. These particles cut off vegetation, scour the surface soil to form fans, pockets and hummocks, and contribute to the formation of dunes on the sandier lands.

To reduce soil blowing, some farmers of the Dust Bowl are using alternate strips of grain and forage sorghums in a strip-crop pattern. The forage sorghums are planted in an equal number of rows of equal width, alternated with strips of grain sorghums of the same number of rows. Forage sorghums usually are cut with a row binder, leaving stubbles from 4 to 8 inches high. Grain sorghums are hand-headed or combined, leaving stubbles from 2 to 3 feet in height. This system, used for the protection of cotton, beans, or fallow, has been found very effective in reducing erosional losses.

Many farmers in this area are using strip cropping to control wind and water erosion and at the same time are making profitable yields of crops.

Strafuss and Son have solved the wind erosion problem on their farm north of Hereford, Tex. When dust storms started in 1933, these farmers realized that a change in the usual wheat tillage methods was necessary. Since that time they have planted wheat in contour strips approximately 170 feet wide, alternated with equal width strips of the previous year's wheat stubble. The following year, these strips of stubble are summer tilled in preparation for the next wheat crop. These farmers have experienced only one complete wheat crop failure during the drought period, which they attributed to damage from soil drifting from adjoining, unprotected fields. They hold the opinion that wind erosion can be reduced to a minimum only through the concerted efforts of all farmers in the area.

George P. Turrentine, a cooperator of the Soil Conservation Service project at Hereford, Tex., is another farmer who is using strip cropping with success. His section of land was broken out in 1927 and was farmed to wheat continuously until 1936. A survey after the 1936 "blow season" revealed that 20 percent of the topsoil had been removed from Turrentine's field. In the Spring of 1936, he planted grain sorghums in a strip-crop pattern. The average width of the sorghum strips was 65 feet, being alternated with 105-foot summer fallow strips on the contour. The fallow strips were kept free of weeds during the summer by the use of a one-way and rod weeder. Wheat was planted in the fallow strips after a 4.13-inch rain late in September. Tests at the time of seeding showed a moisture penetration of 32 inches. Mr. Turrentine harvested and sold \$2,200 worth of milo maize from the sorghum strips, and the yield from the wheat strips was 15 bushels to the acre.

Strip cropping of sorghum, fallow and wheat also has given excellent results on the Soil Conservation Service project area at Liberal, Kans. In 1936, Dan L. Jantzen, who lives 16 miles northeast of Liberal and on the project area, strip cropped 160 acres. Strips of milo were planted on the terrace lines, alternated with strips of summer fallow. The milo strips were approximately 65 feet wide with fallow strips 150 feet in width. At planting time in the fall of 1936, moisture penetration in the fallow was 36 inches. Jantzen's wheat yield was 18.8 bushels to the acre, while an adjoining field which was summer fallowed and farmed in the conventional manner produced 9.3 bushels to the acre.



Strip cropping of sorghum, fallow, and wheat is practiced on the 160-acre farm of Dan L. Jantzen, 16 miles northeast of Liberal, Kansas. Jantzen harvested 18.8 bushels of wheat per acre in 1937, largely as a result of using soil and moisture conservation practices.

These comparative yields furnish evidence of the value of soil and moisture conservation by tillage operations and of the protection furnished by strips.

Louie Lember, another cooperator of the Liberal project, strip cropped a 100-acre field, half to sorghums and half to fallow. After harvesting a ton and a half per acre of grain from the sorghum strips, Lember seeded wheat in the fallow strips on September 14. The moisture penetration on December 11 was 57 inches. Lember harvested 19.4 bushels of wheat to the acre while an adjoining field, not farmed on the contour or strip cropped, showed a moisture penetration of 19 inches in December and failed to produce a wheat crop.

Two brothers, Boyd and Carson Echols, operate a farm 8 miles east of Lamesa, Tex., in cooperation with the Soil Conservation Service C. C. C. demonstration camp. They planted grain sorghums on the terraces with alternate and equal width strips of Sudan grass and cotton in the terrace intervals. Their yields were a ton of grain sorghums and half a bale of cotton to the acre. The Echols brothers state that these yields are more than the farm had produced in the 6 previous years. Conservation of moisture by terraces and contour tillage was responsible for holding rainfall on the field for crop use, while the strips furnished protection against soil blowing.

The farm of S. L. Eason, a Soil Conservation Service cooperator residing 6 miles west of Abernathy, Tex.,

(Continued on p. 107)

Some Maryland Farms Gone Downhill

By Angus McDonald¹

IF YOU want to see a graveyard of farms go out to the Soil Conservation tract² near Beltsville. The old men will tell you that where there is nothing but deserted homesteads and old fields grown up in pines there were once prosperous plantations. They do not remember but they know because their fathers told them.

I went over this land with Thomas Taylor, a farmer in the neighborhood, who knows the old landmarks and plantation sites.

We walked along an old abandoned road up a hill through the woods of pine, white oak, and blackjack. "Now", said Mr. Taylor, "I will show you one of the old plantations." We reached the hill-top. "Look!" he said. There was a little clearing on the hillside and nearby some old abandoned outhouses. Standing like a monument was a huge chimney with two fireplaces, one for the first story and one for the second. The house was gone, carried away or torn down. From where we stood we looked across a little valley to a ridge half-a-mile beyond. The valley disappeared in the rise of trees on either side. I could see there was only scrub timber: dense undergrowth in some places, vegetation part green and part dead, the oak, the blackjack yellow, the pine green. There was no sign of any human habitation, no cleared or cultivated land as far as the eye could see. "This was once a prosperous plantation," said Mr. Taylor. "In the valley there before the Civil War there was a well-kept meadow next to a large apple orchard. Most of the land was in cultivation—corn, tobacco, and wheat. Here is where the old slave houses were. You can see the foundations. The big house was here. Over there, a few hundred yards away, was a schoolhouse long since burned down. Let's walk over the place a little."

Down the hill a little way was a spring from which flowed a brook that wound its way into the valley. We followed one of the old roads down the hillside.

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² Seventeen hundred acres located in the northern part of Prince Georges County, Md.

Nearby was a gully, once a road, worn 5 or 6 feet deep and long abandoned.

"See the old corn rows," said Mr. Taylor. "This land must have been abandoned 75 years ago." The ridges were so slight you could hardly see them. Here and there were fallen decayed trees, burnt stumps, and other signs of fire but covered over-all with a growth of

scrubby timber. In some places it was so thick you couldn't walk through it. Over all the place hung an air of the past. One had the feeling that in spite of the greenness of the woods, there was decay: that the job of agriculture was somehow botched and that Nature, ashamed, was trying to cover it up.

"Why was this land abandoned?"

"Well, you'd have to go back a long way, I guess, to find that out. There are many reasons. A lot of the other farms are in the same fix. This is the worst one."

A long time ago, almost 250 years, Indians hunted and roamed over this land. But the English settlers, ambitious and aggressive, pushed up the rivers, clearing the best land, pressed the Indians back, and put their slaves to work in the wilderness, building homes, and raising tobacco.

One of these hardy pioneers was a Scotchman, an indentured servant, who gradually acquired thousands of acres of land in Prince Georges County. A great hulk of a man, 7 feet tall, was Ninian Beall. He became known as a fearless Indian fighter and was a colonel in the provincial army. He was the first to patent land on what is now the Soil Conservation tract. He took up 400 acres called "Recovery" in 1704. Others followed him slowly. Some of the land was thin and barren but the less sterile parts were patented by 1750.

By Revolutionary times the Tylers, the Duvalls, the Brashears, and the Crosses were settled in the neighborhood. They put in crops of tobacco and corn and impoverished the land. Their slaves cleared new land in the winter as the old fields became worn-out. Joseph Cross, a lieutenant in the Revolution, settled on the place Taylor had pointed out to me. In 1783 he married Lucy Brashears, a descendent of Samuel Brashears who had patented "Brashears Pocosin" in 1717.

By 1825 land in Prince Georges that would raise good tobacco was scarce. The young men moved west as their forefathers had done. But some of the old settlers wanted to stay so they set about to find some way to build up the land. They had heard of

Edmund Ruffin of Virginia. He had done wonders with marl. Other men had used lime and fertilizers of various kinds, and for the first time, after a century of neglect, the land received some consideration. Since 1800 Maryland had been a scene of desolation, old abandoned fields on every side and the land impoverished and worn-out. But the lime users changed this.

Horace Capron settled near Laurel and Charles Calvert near Riverdale. They began to bring the sterile land to life and the Beltsville people took notice. Alexander Keech and William Hall, who lived on what is now the Soil Conservation tract, learned from these men how to make farming pay: more feed crops, lime, marl, stock manure and less tobacco.

The Cross and Hall plantations flourished and the community grew in prosperity and population. Then the Civil War came and the whole agricultural economy was upset. After the war prices fell and labor became scarce. The land in the Soil Conservation tract was never very good; it slipped down below the marginal line and became submarginal. Some of the old settlers left but most of them stayed. The nearby city of Washington was growing and some of them got jobs there, using their homesteads as residences.

And the forest, always fighting against the farmer, began to close in on the cultivated areas little by little. Once there had been good forest on the land—big trees that were good for lumber, houses, and wagons. But the forest could not come back to what it had been. Every 10 years or so fires came. They killed the large timber, destroyed the small, and made natural selection impossible. A few men continued to farm. They raised vegetables and sold them in Washington, but they needed little land for this and once the forest got the land it kept it. It cost too much to clear it—more than it was worth.

One man tried large-scale farming and failed. He farmed on the north side of the tract. Another man, Thomas Taylor, my informant, moved on the land in 1908 and was successful. His farm was on the south side where some of the land was better. He manured, limed, raised livestock, and worked from morning to night improving. "I showed these farmers how to farm," he said. One year he put 3 tons of lime to the acre on one plot of ground. "What a crop I made. A lot of this is all right if it is treated right but it takes work—more work than it's worth. I figure if a man hired this land cleared, cleaned, and the stumps pulled, it would cost \$350 an acre."

Again I walked over this 1,700 acres and I saw more abandoned farms—some of them abandoned

years before the Government got the land. Houses falling down; some of them burned with the massive chimneys sticking up like monuments.

On one of my walks I stopped at a house where someone was living. A hound dog was tied to the front porch. An old man came out and talked to me about the land. Yes, he knew that land. It had been good land once. "My grandfather owned six plantations around here. He was a rich man and made a go of farming. Come into the house and sit down." There were blankets on the windows because the glass had been broken out. When my eyes became accustomed to the darkness I looked at the room. It was filthy; there were dirty dishes on the table and a dog on the bed. The old man lived alone and did his own cooking. He had lost his land and was living in a house not his own.

"Why was this land abandoned?" I asked him.

"It cost too much to work it. It wore out; some of it washed away. We couldn't make ends meet."

"Why didn't you lime it? Improve it in other ways?"

"That takes money. We couldn't make ends meet. We got poorer every year. You know it's funny about this land. My folks owned it a long time. When a person loses his land he loses about everything, I guess." And he looked around apologetically at the room.

EXPERIENCE WITH STRIP CROPPING

(Continued from p. 105)

provides another excellent example of the value of strip cropping. During the 1936 "blow season," soil drifts 6 inches high were formed on a portion of Eason's field, and 3 inches of topsoil were removed from another portion of his land. In the late winter of 1936, Eason constructed level terraces and blank-listed his field with the terraces. In the spring, strips of Sudan were planted along the terraces and the intervening spaces were planted to cotton. Eason harvested 368 pounds of lint cotton to the acre while an adjoining field, farmed without strip cropping and terracing, yielded only 110 pounds to the acre.

L. A. Harral, another cooperator at Littlefield, operates a 1,400-acre farm. In 1937, he harvested three-fifths of a bale of cotton and a ton of milo to the acre from his terraced and strip-cropped field.

Last year, Mrs. Ruby Davis, cooperating with the Soil Conservation Service camp at Lamesa, Tex., strip cropped and terraced a 59.8-acre field with cotton and milo, and planted Sudan in border strips as A. A. A.

(Continued on p. 108)



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



LANDSLIDES AND RELATED PHENOMENA: A STUDY OF MASS-MOVEMENTS OF SOIL AND ROCK. By C. F. Stewart Sharpe. Columbia University Press. 1938.

We all know of Dr. Sharpe as a research scientist in the Section of Climatic and Physiographic Studies of our own Service, and it is most gratifying to know that his book has turned out to be a work of some distinction. Furthermore, and aside from this, the book should be studied carefully by soil conservationists for a better understanding of topographic and soil conditions—for foresight in soil conservation practices, especially structures planned to control erosion on slopes or wherever the soil and rock have the tendency, from this or that cause, to slip downward.

Geomorphologists are greatly interested in Dr. Sharpe's new classification of mass movements as based on kind of movement and relative rate as the primary factor, water or ice content of the moving mass as secondary, and the composition of the moving mass itself as third. In fact, the half-title page of the volume designates it as No. II of the Columbia Geomorphic Studies, edited by Douglas Johnson, who is professor of Physiography at Columbia University. No. I was Douglas Johnson's own work, *Stream Sculpture on the Atlantic Slope*.

The four main headings used in the new classification are slow flowage, rapid flowage, sliding, and subsidence. Rock-creep, talus-creep, soil-creep, rock-glacier creep, and solifluction are classed under slow flowage. Of these phenomena, soil-creep is most significant from the standpoint of soil conservation on agricultural lands; creep is accelerated by deforestation and unwise land use. The rate of creep, which depends on soil type, slope, climate, etc., is at a minimum in loess and pronounced in loose soils. Soil-creep is more rapid in partly saturated soil, slower in arid soils, and is often very rapid (even to debris-avalanche movement) when soil is completely saturated owing to protracted heavy rains.

In his discussion of the causes and the observable evidences of soil-creep, Dr. Sharpe's own careful and rather extensive field studies are indicated. Common evidences described and illustrated are: Displaced posts, poles, monuments, walls, and foundations; curved tree trunks concave upslope; the "stone line" at the base of the B horizon of creeping soil on slopes; roads and railroads out of alignment; turf rolls downslope from boulders. As to causes of creep of the soil mantle, these are separated into two orders—(1) topographic, structural, climatic, etc., conditions favoring creep, and (2) active causes such as weathering agents, load increase, filling and closing of cavities, wedging and prying by roots and animals, and expansion due to freezing water in crevices, to heating and to wetting and swelling of colloidal matter. All causes of creep are brought together in a convenient list at the close of the chapter "Slow Flowage." Of special interest in this part of the book is the discussion of indirect downslope movement caused by frost heaving. An excellent photograph is shown of frost crystals, or needle ice, with the earth and pebbles raised 2 inches and falling downslope as the crystals melt at the base. Under the main title "Slow Flowage," talus-creep, rock-creep, solifluction, and rock-glacier creep, receive considerable attention. Here, as throughout, the author has summarized the significant literature on the subjects and excellent diagrams show the typical relations of talus-creep and soil-creep, frost action and solifluction, and winter talus ridges. As to talus-creep, we learn that the phenomenon is common wherever steep talus exists; that rate of movement depends on climatic conditions and is most rapid in cold regions, as subarctic and above

timber line, where there is alternate freeze and thaw in the interstices of rock waste. This type of creep is slower in warmer climates but is appreciable and easily determined over a period of a few months. In humid climates, wind, rock disintegration and drainage cause talus-creep. Addition of material at the top of a talus always accelerates talus-creep.

Earthflow, mudflow, and debris avalanche are types of rapid flowage, and chapter 4 treats of these intermediate mass-movements. Earthflows occur on gentle slopes with slippery clay beds, while mudflows, which are more rapid because of higher water content and steeper slopes, usually follow stream courses and are often caused by absence of substantial vegetative cover on unconsolidated material. Dr. Sharpe gives interesting accounts of historical mudflows and classifies mudflow types as semiarid (caused by denudation and torrential rains), alpine (the result of snowmelt and sparse vegetation), volcanic, and outflow or "bursting" of bogs.

Dr. Sharpe describes debris-avalanche as "a flowing slide" the initial movement of which is caused by slippage. Debris avalanche is almost always preceded by heavy rain, increasing weight, and lubrication, and may occur in humid areas well covered with vegetation.

The author defines a landslide as "the perceptible downward sliding or falling of a relatively dry mass of earth, rock, or mixture of the two." Types (slow to very rapid) are slump, debris-slide, debris-fall, rockslide, and rockfall. Slumping is discussed at length as significant, along with soil-creep, in agricultural areas. Slumping is responsible for the development of terracettes and may occur in columnar clay, loess, stratified silts, sands and fine gravels or wherever conditions are favorable to sliding. Dr. Sharpe tells of various methods of treatment to prevent and check the slide of slump—lowering water content of mass by drainage, artificial freezing of slide, rip-rap fills, artificial drying with hot air blown through a system of drilled holes, concrete casings (in weak shale bedrock) walls and fences, spraying with heavy oil or gunite to keep out water.

In conclusion, Dr. Sharpe presents an ingenious diagrammatic classification of landslides and related phenomena, and brings together the types of mass-movements to show that they form "a continuous series, grading from mass-movement of dry earth or rock into mass-transport by fluvial and glacial processes." A classified bibliography lists 275 selected references "dealing with general principles and * * * describing individual types of flow and slide phenomena."

EXPERIENCE WITH STRIP CROPPING

(Continued from p. 107)

diverted acreage. She produced 19 bales of cotton from 24 acres, 800 pounds of milo grain from 27.8 acres, and let the Sudan remain on the field for protection against wind erosion and to check run-off water. In 1936, this field had produced only 8 bales of cotton on 30 acres and 600 pounds of milo on 29.8 acres.

These results indicate that strip cropping is a practical and inexpensive method of permitting the safe use of fallow and profitable nonerosion-resisting crops. This practice definitely has a place in a well-coordinated program of soil and moisture conservation for prevention of soil drifting and at the same time facilitates a well-balanced system of farming whereby forage crops can be produced on the farm each year.

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Soil Conservation Service

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Advance Report on the Sedimentation Survey of Hayes Lake, Hayes, S. Dak. (In cooperation with the South Dakota Agricultural Experiment Station.) June 8-15, 1937. mm. SCS-SS-20. July 1938.¹

Advance Report on the Sedimentation Survey of Mission Lake, Horton, Kans. (In cooperation with the Kansas Agricultural Experiment Station.) April 15-May 6, 1937. mm. SCS-SS-22. July 1938.¹

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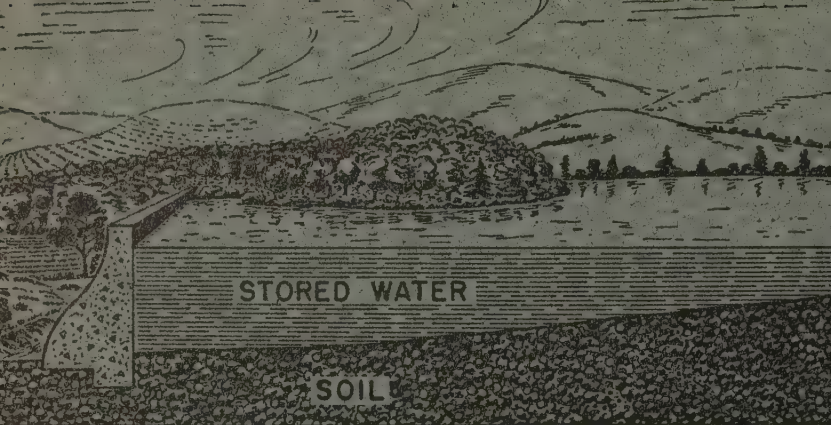
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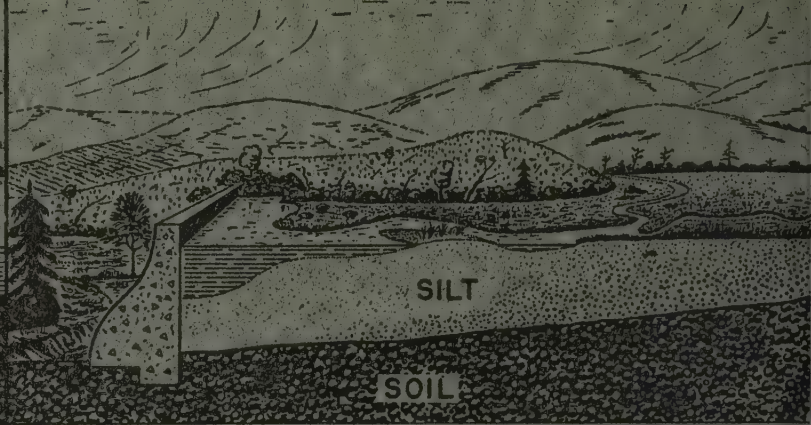
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Reservoir at full storage capacity



Reservoir capacity lost by silting



Productive Cornfield

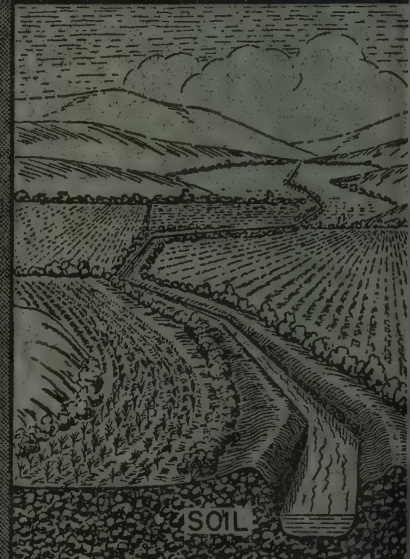


Cornfield damaged by sand

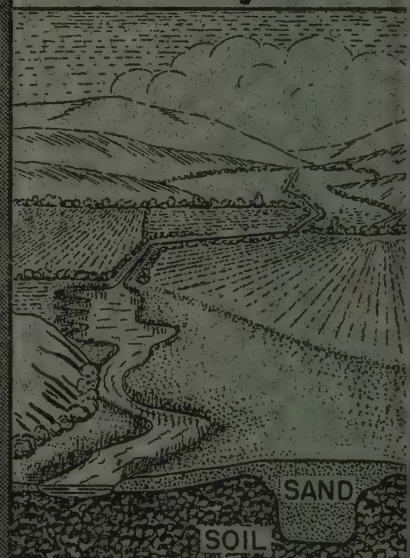
EFFECTS OF SEDIMENTATION

Soil erosion damage is not confined to the farms from which soil is removed. It may be repeated many times by sedimentation along the route which the eroded soil travels toward the sea. Silting destroys the value and usefulness of reservoirs built for irrigation, power development, municipal water supply, and recreation. Drainage ditches are filled. Sand covers bottomland fields, rendering them sterile and unproductive. Aggradation of river beds causes obstruction of surface drainage and more frequent and higher overbank floods.

Thus sedimentation multiplies the costs of soil erosion because valley farmers, industry, and cities all suffer from the effects thereof.



Drainage ditch



Sand filled drainage ditch



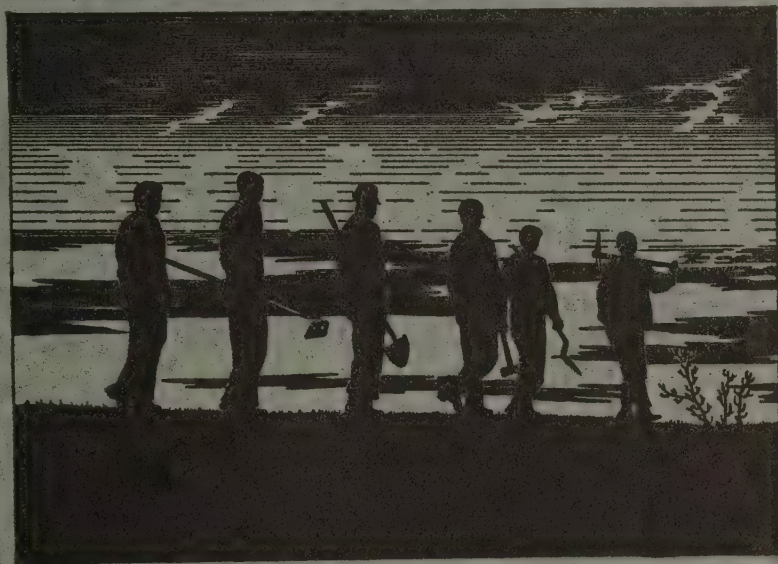
Improved agricultural valley land



Swamping of valley by rising river bed

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



NOVEMBER
1938

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WELLINGTON BRINK
EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

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H. H. BENNETT
Chief, Soil Conservation Service

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Raw, eroding streambanks permit swollen streams to cut deep into fertile bottomland, and add to the silt load.

Willows for Streambank Control

By J. R. Fry, Jr.¹

THE rugged topography of southwestern Wisconsin, consisting of narrow ridges breaking off in steep slopes to the valleys below, permits rapid runoff of rainwater which endangers the banks of even the smallest streams. One of the problems of Service technicians in this area, and particularly in the Coon Creek project, has been the development of a practical method for protecting streambanks, so as to prevent destruction of fertile bottomland and to decrease the silting and flood hazards downstream.

Sudden, intense thunderstorms are common during the summer months and streams frequently overflow their banks and cause serious damage to adjacent lands. Coon Creek, for example, has a normal flow of 40.3 cubic feet per second and a silt content of 267 tons per day at the Coon Valley gaging station, halfway mark

¹ Project forester, Coon Creek project, Soil Conservation Service, Coon Valley, Wisc.

between the headwaters and the mouth. In flood stage it has had an instantaneous flow of 8,110 cubic feet per second and a silt load of 36,800 tons per day. Under these flood conditions streams cut deep gashes into rich bottomland fields and pastures, often ruining the land for cultivation and adding greatly to the silt load, especially where streambanks are left unprotected.

Since the spring of 1934 various vegetative and mechanical methods have been employed in the Coon Creek project to protect streambanks. Live willows have been used in a number of ways with varying degrees of success. No difficulty has ever been experienced in getting the willows to sprout and grow under favorable conditions, but it became evident as the work progressed that the growing willows require protection from flood waters until they be-



After sloping the bank, willow poles and brush matting have been laid to prevent further cutting. The rock-toe wall protects the matting until willows become established.

come well established. Brush-rock wing dams, piling, timber cribs, and bulkheads furnished this structural protection, and willow slips were planted successfully on the downstream side of the structures. However, this necessary precaution greatly limited the use of willows in streambank work. Another method was needed that would incorporate mechanical protection with the willow planting itself.

After 2 years of trials a method has been developed that has proved very effective and may now be considered for more extensive use. The eroding streambank, which generally is raw and vertical, is first given a 1:1 slope, and most of the loose earth is piled above the sloped bank. At 4- to 5-foot intervals shallow trenches are dug from the water's edge to the top of the bank. Willow poles are placed in the trenches with the butts forced into the muck beneath the water level and the poles extending the full height of the sloped bank. The trenches are then filled with soil until only the upper third of the pole for its full length remains exposed, after which the poles are securely fastened to the bank with willow stakes and No. 9 smooth wire.

The exposed portion of the bank between the poles is thatched, from slightly beneath the water level to the top of the bank, with bundles of willow brush. The effect is much like that of shingles on a roof. Care must be taken, however, to avoid covering the partially buried poles, since this would seriously limit their ability to sprout. The brush thatching and poles are next covered with one or two widths of hog wire laid at right angles to the willow bundles. The

hog wire is tied to the bank with willow stakes and No. 9 wire. Poles are sometimes laid over the hog wire, and at right angles to it, as an additional safeguard. These poles are likewise tied to the bank with willow stakes and No. 9 smooth wire. The toe of the bank should be riprapped with rocks to prevent the stream from undercutting the brush matting. Finally, the loose earth piled above the bank is scattered over the willow bundles to fill up the air spaces and maintain the moisture necessary for sprouting.

A streambank treated in this manner receives immediate mechanical protection in the riprapping and brush matting. Within a short time the partially buried poles, willow stakes, and brush matting all produce sprouts which become progressively more capable of withstanding flood waters. At the end of the second growing season the shoots average about 6 feet in height and are well able to take care of themselves without the aid of the decaying portions of the brush matting.

A simplification of the foregoing construction method shows considerable promise and will undoubtedly result in lowered costs. The brush matting has sprouted so profusely that it is believed possible under certain conditions to eliminate the partially buried willow poles. When the height of the sloped bank does not exceed the length of one tier of willow bundles, the initial series of poles seems to be unnecessary, since sufficient sprouts may be expected from the matting alone. It may also be possible to eliminate either the hog wire or the poles which surmount it. In the event that the hog wire is excluded,



Under control. The willows have made enough growth in 2 years to afford permanent protection to streambank. They also reduce silting, increase fish food, furnish splendid coverts and travel lanes for wildlife.

poles must be run at right angles to the bundles to hold down the brush matting. Riprapping the toe of the bank with stone is an essential safeguard, however, and should not be neglected.

Almost all species of willow common to this area have been used successfully in streambank work. Sandbar willow (*Salix longifolia*) has been employed most extensively because it has been most readily available, and has been very satisfactory in every respect. It is of prime importance that a "brush" type of willow be used in this work, although this, of course, is not always possible when willow poles are expected to furnish part of the growth. "Brush" willows grow very densely and from a compact mass of comparatively small roots which effectively bind the soil to the bank. Because they never develop into tree size, they maintain their density and do not shade out other willow shoots. Their small diameter enables them to bend over during a flood and thus form a protective thatching over the bank. In this area they have not lowered the capacity of the streambed by encroaching upon the stream, and they are easily controlled in fields by cultivation.

Since willow matting and brush-rock wing dams may often be used interchangeably, it is desirable to compare the two methods. The costs of willow matting and wing dams are about the same per linear foot of streambank protected. With the simplifications suggested, the costs may be in favor of the brush matting.

Streambank planting must be protected from live-

stock damage by fencing or some other means. It is not essential to protect wing dams; if they are to become permanent living deflectors, however, they must contain willow brush capable of sprouting, in which event they would require protection. But even protected wing dams may not need as much fencing as long stretches of willow matting.

Wing dams may be constructed any time of the year, although they are commonly built during the winter when other work is impossible or impractical. Willow matting may be laid whenever the willow is in a dormant stage. Equally good results have been obtained from fall and spring construction. If much bank sloping must be done, willow matting usually will have to be laid, for economy's sake, when the ground is not deeply frozen. This is not the case with wing dams which, to ensure permanency, should be built when the willow brush is dormant.

Willow matting is of somewhat less complicated construction than are wing dams, and no technical training or experience is required to determine its location. The matting merely protects the bank, enabling the stream to follow its normal course with little deflection. The principle of wing dams, however, is to deflect the current away from the eroding bank, and the altered current sometimes starts cutting the opposite bank, thus necessitating another structure.

In addition to affording excellent natural protection for eroding streambanks, willow thickets along stream-

(Continued on p. 128)

Erosion and Drainage

By J. Frank Relf¹

"The most instantaneous and effective of all fresh water reservoirs is the soil."—Allen Hazen in *Flood Flow*, page 154. New York, 1930.

TODAY it is apparent that one of the menaces of our great Corn Belt (loessial soil region) is the approach to a complete drainage of the rolling tableland by surface and subdrainage, much of which is caused by erosion. Streams that formerly flowed continuously now are intermittent. Many wells which once provided abundant fresh water have been lowered or have failed. Crops suffer more during prolonged periods of abnormally low precipitation than when the land was new. Yet climatological data, recorded over a long period of years, indicate little change in the yearly precipitation of the area.

During the period from 1909 to 1912, in the Nemaha Valley, which runs through northeastern Kansas and southeastern Nebraska, large open drainage channels were constructed to drain off floodwaters after heavy rains. Formerly these waters flooded the valley for a week or 10 days, but now they drain off through the new open channels in 24 to 48 hours. The open channels have provided an outlet not only for the floodwaters but for the surplus water on or in the soil as well, and as a result, 71,300 acres of rich wet overflow land are well drained by the system. The groundwater table that formerly stood at or near the surface of the valley has been lowered by subdrainage. This is a good example of drainage of the soil by open channels.

Our vast rolling tableland with gentle sodded valleys has been eroded and dissected into small areas (residual bench areas) by a checkerboard highway system and numerous gullies which branch out from the parent streams. The highways and the gullies form a drainage system that aids gravity in draining the surface and ground water from the adjacent areas in a short time.

Changes in southeastern Nebraska will illustrate drainage as resulting from highways and erosion. In the comparatively short period of 65 years the trails running directly from one trading point to another were replaced by a system of highways. Gullies advanced from the two parent streams through each valley. Today the road channels and numerous gullies provide an easy and quick drainage.

(Continued on p. 114)

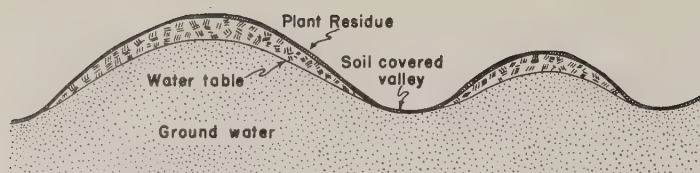
The Story in Pictures

1. A great cavity 27 feet deep, 57 feet wide, branching off from the main gully and advancing up through a gently sloping cultivated field. The overfall has crossed the public road and crept into the field within the last few years. A temporary bridge is back in the field. Small springs and seepage flowing from the base cause the vertical banks to cave in. Water flowing over the overfall will soon dissolve the caved-in soil and carry it down the gully to add to the fill in some stream. Surface and subdrainage are greatly accelerated in this field, as compared with the sod-held valley shown in picture 6.
2. A 30-foot bridge over a 23-foot gully, in Nebraska. During a dry period in 1936 when small plants in the cultivated fields were badly needing moisture, ground water was seeping out of the base and flowing down the gully, as shown here. Continuous drainage will soon lower the water table in the adjacent field.
3. Well-graded roadbed running uphill, a typical example of many graded roads in the rolling tableland. Usage and erosion have removed considerable quantities of soil from the disturbed area. The road channel where the man stands is $4\frac{1}{2}$ feet below the surface, while the shoulder of the road grade (marked by the stake) is 1.8 feet below the surface of the adjacent field. Water falling on the field sloping toward the road, and that which falls on the road, will be quickly removed by drainage to a channel or gully at the base of the hill. The exposed bank along the fence line will lose considerable moisture by evaporation.
4. This advancing gully now has an overfall $11\frac{1}{2}$ feet deep at the edge of the concrete slab. It will soon take the public road and continue upward, to menace the adjoining field.
5. A huge icicle on the side wall of a vertical inlet to a culvert. A smaller icicle resulted from seepage through a weep hole in the lower left corner. The culvert is located in a gully 37 feet deep. Freezing of the ground surface and covering with snow obviously did not stop subdrainage of the area.
6. A sodded valley between two cultivated fields tends to hold the run-off water and silt. The water flowing on to the area at the lower left was retarded and spread out over the entire lower portion of the sodded valley without erosion during the February 1937 thaw, while unprotected valleys and gullies were accelerating the run-off and eroding very badly at the time.
7. The gully at the left started from a small road ditch. It is working up the hill alongside the road and gnawing gradually into the sloping field at the left.

¹ Associate agricultural engineer, Soil Conservation Service, Stillwater, Okla.



(Captions on opposite page)



Loess soil profile in 1857, showing relationship of water table to surface of soil. Water then sought a level near or at the surface in the valley, some depth below the surface on the hill.

(Continued from p. 112)

The drainage of the township as it was 65 years ago allowed run-off water to travel long distances over well vegetated valleys, while the excess ground water found outlets through the numerous springs along the parent streams. The retarded movement of run-off water over a highly absorptive soil permitted a large amount of water to percolate into the soil, thus providing an abundant supply of ground water for plants and streams. It is no wonder that the area now shows the effects of drought during periods of low precipitation. Erosion has removed a large percent of the topsoil, exposing a tight and more compact soil that is susceptible to excessive run-off. Gullies and road channels surrounding each small area receive the run-off and carry it rapidly to the major streams. Water that should be retained in the ground where it falls is lost.

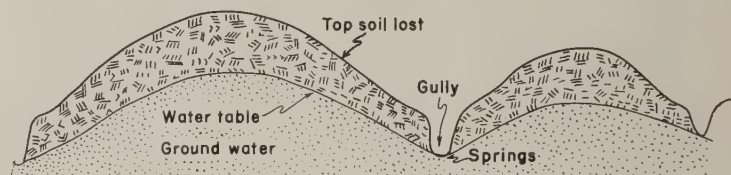
Drainage consists essentially in the direct removal of surface and ground water from the soil. An open channel, whether natural or artificial, provides free passage for surface and ground water. Hence, a gully or road ditch is simply a means of aiding gravity in removing run-off and stored ground water. The free passage of ground water into a gully (subdrainage) may lower the water table or deplete the supply stored in the soil to the extent that vegetation will suffer during dry seasons.

On the other hand a well-sodded valley retards surface and subdrainage, thus allowing a greater supply of water to be stored in the ground for plant and domestic uses. The run-off from intense rainstorms is carried gradually to the parent stream, thus reducing local floods, while the excess ground water drains gradually through the porous soil and crevices to springs which in turn feed the larger streams with a constant supply of clear water.

In addition to an ample supply of ground water, the sod-covered valley retards the surface run-off to the extent that in many instances the fertile valley is not suitable for agricultural crops because of the excess water. However, it usually makes good pasture or hay land.

Intensive farming practices led the farmer to plow up the valley and drain off the excess water by drawing

a furrow down through the valley to an outlet. The highway official, to maintain a dry roadbed, cut a ditch on each side of the road grade for speedy removal of all water falling on the road and the run-off from the adjacent field. Water flowing through the little furrow in the valley or the road channel down the hillside soon developed an overfall which in a comparatively short time worked back through the valley, producing a gully often 25 to 35 feet in depth. The farmer and highway official were little concerned at first about the advancing gully as it was an aid to gravity in draining the wet farm land and the highway. Later, however, they became deeply concerned as the main gully deepened and widened with numerous fingers branching out from each side and advancing rapidly up the slope to dissect the field into small residual areas or to destroy the entire area.



The profile 65 years later. Wasteful usage has removed a large part of the rich topsoil. A gully of considerable depth has aided gravity in draining the valley of both surface and ground water. Increased slopes and compacted soils have increased and accelerated the run-off. It is reasonable to assume that the ground water in the adjacent high lands is also being lowered or depleted.

An examination of many of the gullies in the loessial region reveals springs or seepage flowing out of the banks near the gully bed. Many of the springs or seeps flow continuously throughout the year subdraining the soil of its supply of stored ground water. The water table that was near the surface has drained down until it stands several feet below the surface of the valley—this due to surface and subdrainage by gullies and road ditches. It is reasonable to conclude that the whole water table in the area adjacent to gullies also has been lowered and the partial supply of stored ground water is now insufficient for plant and animal life during abnormally low rainfall. Furthermore, the accelerated run-off from the residual field to the nearby gully or road channel is carried quickly to the major stream, adding materially to periodical floods.

TENTATIVELY SCHEDULED

January—Engineering

March—Wildlife

MANY of the early attempts at soil and moisture conservation were centered in the eroded plains east of the southern Great Plains and in some of the southern counties of the Texas Panhandle. Although definite dates are lacking, it seems probable that both level terraces and contour tillage without terraces were tried by different individuals in some parts of the area as early as 1918. For the purpose of this paper, however, the history of level terraces began in the southern Great Plains region on two State experiment stations, one located at Goodwell, Okla., and the other at Spur, Tex. In 1926 the first crops were harvested from land under treatment on these two stations.

Data from the Panhandle Experiment Station at Goodwell show that the yields of wheat and sorghum are increased by level closed-end terraces on a Richfield silt loam soil. This experiment station is in the southern Great Plains region where the average annual rainfall is 17.48 inches.

These studies were conducted on a series of alternately terraced and un-terraced plots. The plots were so established that moisture readings could be obtained on terraces spaced from 40 to 350 feet. The plots were 350 feet in length, running down the slope which averaged 0.7 percent, and were diked on all sides to prevent run-off and the encroachment of water from adjoining areas. The plots were one-fifth of an acre in size.

The Spur Station in Dickens County is located in the rolling plains region of northwest Texas, on Miles clay loam soil. Data show that the average annual rainfall at the station is 21.36 inches, 85 percent of which falls during the growing season for summer crops, and that of the total rainfall received 20 percent occurs in light ineffective showers while another 20 percent is lost by run-off. This leaves only 60 percent to be absorbed by the soil for crop production.

The studies indicate that tremendous water losses occur on areas with very little slope. Crop yields from the field areas show that in general water can be saved by contoured rows, level closed terraces and dikes, and that the yields of crops are in proportion to the amount of water saved.

Cropping level terraces in the Dust Bowl may be considered as an attempt to use efficiently the moisture that has been stored before planting time or which may be encouraged to soak into the ground during the growing season, to ensure proper growth of the best adapted crops and to provide enough litter therefrom to protect the land against wind erosion. For these purposes, let us apply the mechanical and vegetative

FARMING LEVEL TERRACES IN THE DUST BOWL

By Fred C. Newport¹ and Robert R. Hinde²



End-closure and terrace base producing milo. Terrace interval seeded to wheat parallel to the terrace.

1.

methods of soil and moisture conservation to a terraced field with respect to, first, the terrace ridge and end-closure, second, the terrace interval or space between terraces, and third, the irregular interval between terraces—the point-row interval.

Before the terrace ridges and end-closures are planted to any crop, considerable study should be given to the condition of the soil in the surrounding fields. If the lack of organic material seems to indicate blow conditions, these structures should be planted to some fibrous-rooted crop such as sorghum, preferably close drilled. The barrow pit on each side of the ridge is an ideal place on which to plant milo or forage sorghums. This gives an opportunity to open the land where wheat is grown without the “drive over” loss of wheat, and also it helps to reduce the hazard of lodging in wheat fields along the terrace ridges in case of excess rainfall during harvest season or immediately before. Should the terrace ridge and end-closures be too narrow and steep for seeding, rows of crops may be planted for protection against soil movement. These strips may be wide enough on each side of the ridge to allow for widening of the terrace ridge without interfering with the wheat crop.

All tillage operations in close proximity to the terrace ridge should be parallel to it. A tool which

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Terraces producing sorghum, and cotton growing in the point-row interval. A "through" of Sudan covers the turn-row space in the point-row interval.

2.

leaves a furrowed and cloddy surface should be used. After the ridge is completed, weeds should be killed, following the rains, by using a shovel-type implement which will not reduce the cloddy surface effect before planting.

Harvesting with the terrace, especially where the cross section of the terrace is steep, offers advantages. A cleaner job of cutting on the ridge is expected when the combine follows the terraces—breakage of harvesting machinery often results when the steep and narrow terraces are crossed. A 20-foot combine has been used effectively in harvesting the broad-base wheatland terrace. Stubble should be left as high as possible when combining or when harvesting a row crop that has been grown on terrace ridges. This will help to prevent the ridge from washing in the event that it over-tops, and will reduce the irregularity of accumulations or removals on the ridge by wind erosion.

After the terrace ridge has been constructed the problem of its maintenance is forever with us, and care should be taken at all times to prevent the ridge from working down. A good practice in ridge maintenance is to plow the dirt toward the middle of the ridge and allow all possible litter to be worked into the ground in and adjacent to the ridge. Wing plows and disks are good implements for this purpose. An occasional treatment with a blade often makes for effectiveness in the cultivation and maintenance of the terrace ridge.

The terrace interval, from a practical point of view in soil and moisture conservation, should be considered as a small field or a "land." The first problem then is to determine the crop or crops to be planted within this small field between each two terraces. If more than one crop is to be produced, the arrangement of the pattern should be decided as early as possible. This

facilitates efficient seedbed preparation and proper row arrangement—the direction and arrangement of rows and drill furrows play an important part in encouraging the water to go into the ground where it falls, and in reducing the concentration above the terrace ridge.

If a drill crop is to be used and if sorghum has been planted on the terrace ridge, in preparing the seedbed the implements may travel around the "land" made by each two terraces, especially if the equipment is old-type and a little difficult to turn. This process of working rows and furrow slices from each side of the "land" will finally work out the irregular interval at mid-point between the two terraces. If modern equipment is available and a general-purpose tractor is used, the seedbed preparation may be backward and forward from one terrace until mid-point between the two terraces is reached. Then move over to the other terrace and work backward and forward until the last long row from this side meets the last one from the other side. Plow out the irregular interval by taking a "through" off first the one side of the triangular "land" and then the other, turning right and left and leaving a three-cornered, unplowed space between "throughs" on the center line between terraces, which can be plowed out

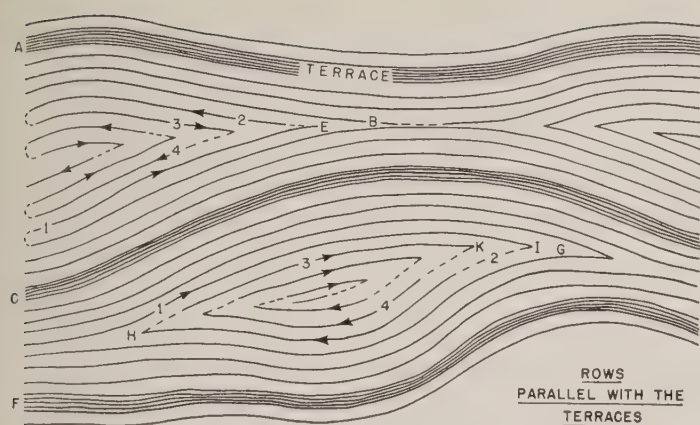


Terraced ridge growing broadcast sorghum, with interval to cotton being cultivated parallel to ridge.

3.

by a finishing round or "through." Implements that leave a cloddy surface with furrows are desirable, especially where the soil is deficient in organic material. Chisels, listers, and shovels have their respective places in this type of seedbed preparation.

Weed control is an important item and should be considered with the timeliness of tillage operations. Where plowing with shovel-type implements immediately follows a rain, little moisture is lost from weed growth and a rough surface to reduce soil blowing can be maintained.



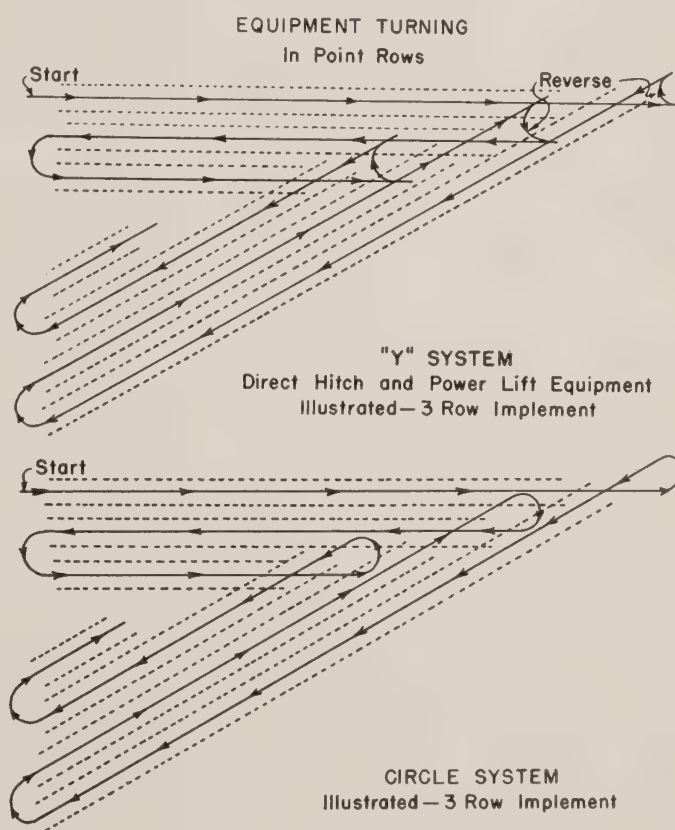
Seeding operations should be closely associated with the amount of moisture in the soil at seeding time and the quantity of residue in and on the ground. Falling rain soaks into the soil more rapidly where the furrows made by grain drills are run parallel with each terrace or level. Deep and semi-deep furrow drills seem to be more advantageous than the surface drill for this particular purpose; likewise, they appear to be beneficial in checking the drifting snow. Some farmers prefer to take the interval between two terraces as a "land" for seeding purposes, while others prefer to drill backward and forward away from each terrace until they have reached the half-way distance between the two and then work out the irregular intervals in a "land," double drilling across the corners.

It seems advantageous to harvest the grain in the same direction in which it was drilled. If acreage between each two terraces has been used as a "land," it may be combined in the same way. Some farmers claim that little difficulty is encountered in crossing drill furrows with the combine if the furrows are of the flat-surface type and are not crossed at right angles. It is desirable at harvest time to leave all the stubble possible and at the same time harvest all the grain. Especially is this true from a wind-erosion prevention point of view. The practice of following the combine with the lister where moisture is available, or with the disk or chisel where it is dry, seems to be profitable for early seedbed preparation.

Where row crops are to be used in the terrace interval, it is best to determine the amount of each, and at the same time the balance between fibrous-rooted and tap-rooted crops, and between fibrous-rooted crops that are to be harvested in the bundle as forage and those, such as milo, which are to be harvested as grain crops. From a soil- and moisture-conservation point of view, it is extremely important that the rows be run parallel to each terrace. The time of bedding, listing or chiseling may vary with the soil type, locality and rainfall, but in any case it should

be deep enough to secure a cover of loose dirt over the bottom of the furrow. Soil drifting usually is in proportion to the amount of vegetation on the ground. Where early listing is necessary and weed growth prevails some farmers re-bed the land, while others plow, harrow or knife the beds.

If the crop arrangement is determined soon after the field is bedded, it will be easier to prepare the land for planting when the different planting dates and seasons arrive. Sorghum and cotton, when moisture is available, may not be planted at exactly the same time. They are planted in the furrow and cultivated with a knife or shovel, by much the same method. Enough cultivation to prevent weeds from using the moisture necessary to the development of vigorous normal crop plants is about all that is necessary. The omission of a final late cultivation allows an early fall grass and weed cover on some of the fields; this cover prevents soil blowing and does not materially reduce crop yields.



Methods of harvesting row crops naturally fall into two groups: First, hand harvesting, as picking or snapping cotton and heading maize; and second, machine harvesting, such as binding forage sorghum, combining milo, or field chopping of silage. It is important that machine-harvested crops be cut high enough to leave a stubble that will serve as a barrier to break up the ground sweep of the wind; or that properly spaced alternate strips of high-stubble row

crops are used with those that may leave a low stubble. Lack of moisture may sometimes reduce the height of bundle feed to such an extent that it is impossible to bind the crop and at the same time leave the desired stubble height. If the farmer needs the feed he will be likely to cut this stubble low and then run a chisel, about 10 inches deep, between each row before the blow season starts.

Beans, cotton, and potatoes are harvested by methods which do not leave sufficient trash on the ground to prevent wind erosion. With these crops we must depend upon the sorghum family, in strip-crop patterns, to help in holding the soil on the fields.

Unless the best known methods are used in managing the irregular intervals between terraces the farmer often has considerable difficulty in working them into his farm operations. It is not always a simple matter to determine the proper land use for these irregular tracts. Farmers themselves vary on this point. Farmers in the cotton section have no objection to working these point rows in cotton, milo, or Sudan. The crop is planted and cultivated in much the same manner as is used when laying in the point rows at the time of preparing the land. The methods used in turning the machinery in the point rows will vary with the different types and makes of implements. With the all-purpose tractor, it appears easy to turn right and left and plow point rows of very short length. If some forage sorghum is required on the farm, it is not at all difficult to use the point row interval as a supplement to a protective strip of row crops. In this case, the desired number of long rows of forage sorghum might be planted adjacent to point rows of milo or cotton and serve to break up the wind current and help in reducing wind erosion across the cotton strip. These intervals are also used as an acreage in which small grain is planted as a protective strip, although there is some objection to the extra turning of the grain harvesting equipment. Some farmers dislike to turn grain binders or forage binders in point rows and prefer planting such intervals to milo or to cotton where hand harvesting is practiced.

Where native perennial grass can be established on the land, or where hay is adaptable, these irregular spaces may be diverted into permanent buffer strips and supply a part of the hay needs for the farm. Where moisture is available such crops as alfalfa or sweetclover may properly occupy these spaces. One governing factor in determining the kind of crop to be planted in the irregular or point row intervals and the total width of this crop, is the distance between terraces in combination with the kind of crop planted on

the terraces, especially if the strips in such intervals are intended to be effective in reducing water and wind erosion between terrace ridges.

Crop yields from areas using level terraces are interesting. The results of terracing experiments at Goodwell show that an increase of 4.39 bushels of wheat was secured from the plots during the period from 1926 to 1931 inclusive.

Data from the experiments at Spur show that in 1927 the seed cotton yield was 169 pounds greater on areas having closed terraces than on the area having open end terraces; it was 233 pounds greater in 1928. The field, which was diked and terraced by the syruapan system of diversion terraces, produced 441 pounds of seed cotton in 1928 or 88 pounds more than the average yield of the four areas using open end terraces.

Studies on the Dalhart Soil Conservation Service project reveal the following concerning crop yields on all soils except sandy types: On 20 terraced fields there was an average production of 723 pounds of grain sorghum per acre; 21 contoured fields produced an average of 589 pounds per acre; 7 fields with straight rows produced an average of 461 pounds per acre.

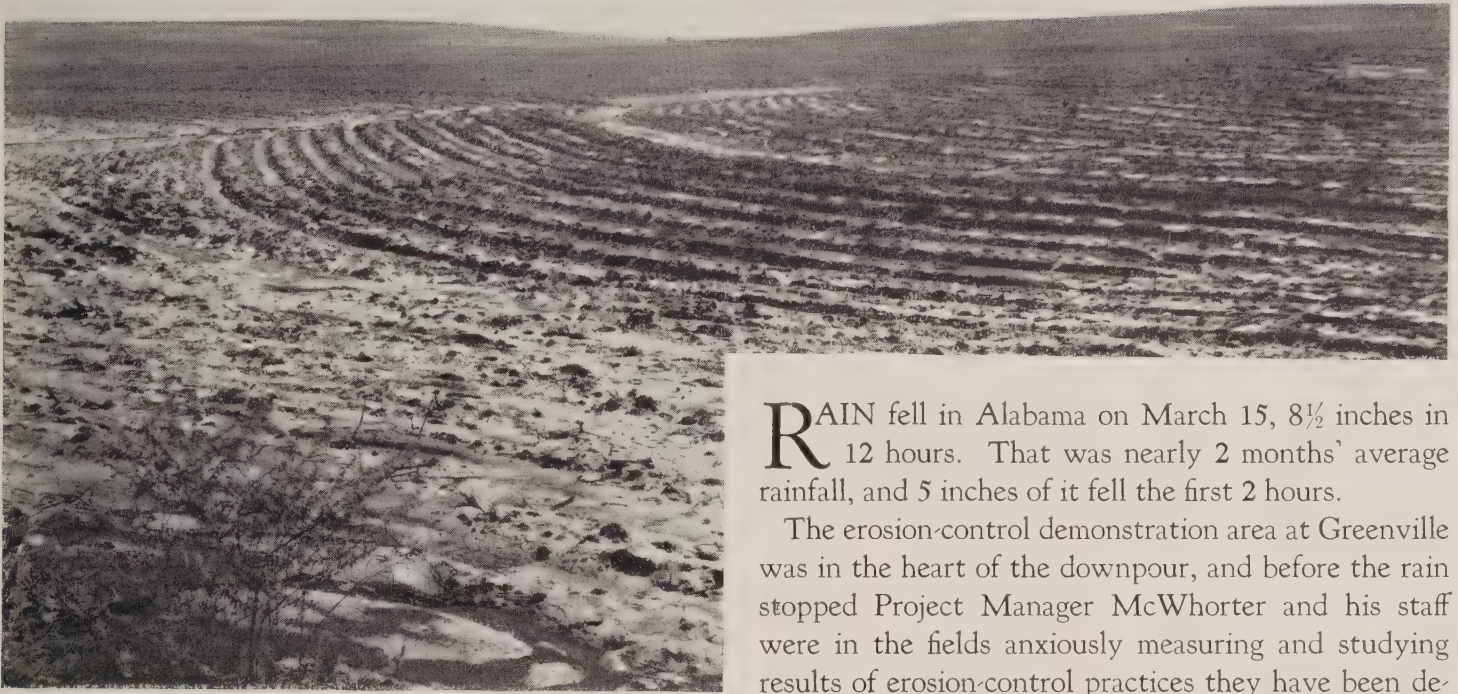
Observations of wheat yields for 1937 from the Soil Conservation Service project located at Vega, Tex., indicate that one field, terraced previous to the spring rains on fallowed land, produced 18 bushels per acre; 6 fields terraced after the spring rains on fallowed land produced 6.9 bushels; 12 fields terraced after spring rains, following a crop, yielded 2.2 bushels; 20 fields, contour drilled on fallow land, yielded 9.25 bushels; 13 fields, contour drilled after crop, produced 2.8 bushels; 7 fields, straight row drilled on fallow, produced 7.6 bushels; and 24 fields, straight row drilled after crop, yielded 2.2 bushels.

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RAIN FELL IN ALABAMA

Contour listing and good terraces checked the damage in this field.



RAIN fell in Alabama on March 15, $8\frac{1}{2}$ inches in 12 hours. That was nearly 2 months' average rainfall, and 5 inches of it fell the first 2 hours.

The erosion-control demonstration area at Greenville was in the heart of the downpour, and before the rain stopped Project Manager McWhorter and his staff were in the fields anxiously measuring and studying results of erosion-control practices they have been developing on 140 farms in the area during the last $2\frac{1}{2}$ years. This was a severe test.

The study following that near-record rain gave further real evidence of the value of strip cropping and close-growing cover crops to support terraces in controlling erosion, and brought out some interesting facts about terracing and strip cropping on different degrees



But look at the havoc where the rows were grooved up and down the hill!

By Ralph Fulghum





Terrace interval covered with oats showed very little sanding. Picture taken below strip of oats.

of slope. We present some of those facts here as observations—to point them out rather than to interpret them as final conclusions.

To check the value of strip cropping and close-growing vegetation, soon after the rain the staff examined about 15,000 feet of terraces below strips of close-growing vegetation, and about 15,000 feet of terraces on the same soil type but below bare terrace intervals. They found three times as many rills in the bare terrace intervals, twice as many breaks per mile, and twice as many sandbars or deltas in the terrace channels below the bare intervals as in those below the close-growing strips, as shown in the table.

[All soil Akron fine sandy loam with 37 or 337 erosion class]

Slope	Treatment	Total length of terraces checked	Number of terrace breaks per mile	Number of rills halfway through terrace interval per mile	Number of sandbars or deltas in terrace channel per mile
		Feet			
0 to 5 percent.....	{Cover.....	6,300	5	27	21
	{No cover..	6,125	10	46	28
5 to 10 percent....	{Cover.....	8,900	3	25	15
	{No cover..	9,200	8	117	52
Total or average..	{Cover.....	15,200	4	26	18
	{No cover..	15,325	9	81	40

The table shows that there were more terrace breaks per mile on the more level or 0- to 5-percent slope than on the 5- to 10-percent slope. Probably that is because the terraces were built on a variable vertical interval basis and the terraces were much closer together on the steeper slopes.

Also note that on the 0- to 5-percent slopes there were 27 rills per mile (indicating sheet erosion) in the covered terrace intervals compared with 46 rills per mile (not quite twice as many) in the bare intervals. The difference on the steeper or 5- to 10-percent slopes was far greater, there being nearly five times as many rills in the bare intervals as in those covered with close-growing vegetation. This indicates that while



Companion picture taken above strip of oats. Sanding in terrace channel below interval lacking vegetation. Interval contour bedded.

strip cropping with close-growing vegetation reduces erosion on the more level land it is even more necessary on the somewhat steeper slopes to check rills and sheet erosion between the terraces.

The project engineer also made a further study of terraces on different slopes, with and without cover in the intervals above. He started at the crest of 100 terraces in each of three slope classes—50 terraces below strips of oats



A good cover of Austrian winter peas. No damage here, although serious erosion occurred on nearby fields.

or vetch or winter peas, and 50 terraces below bare terrace intervals—and measured the distance to the first break in the terraces. The following table gives the results:

Slope	Number of terraces broken		Percentage of terraces broken		Average distance to first break	
	Cover	No cover	Cover	No cover	Cover	No cover
0 to 5 percent.....	12	27	24	54	933	450
5 to 10 percent.....	20	35	40	70	580	360
10 percent and more.....	20	28	40	56	430	393

This study also shows that close-growing vegetation in the interval above greatly reduces the number of breaks in the terrace, but it is also evident that the



Oats afforded valiant protection to the back and lower sides of this terrace. Severe drainage was suffered by the uncovered land above.

difference between the number of breaks in terraces below close-growing strips and those below bare intervals diminished as the slope increased. This again, no doubt, was due to the fact that the terraces were built on a variable vertical interval basis, and

thus the terraces were much closer together on the steeper land and had a smaller total volume of water to carry.

A little further figuring will show that vegetation

(Continued on p. 124)

Even a good terrace needs a cover, to withstand such a severe test. Vegetation would have prevented the rilling. The rope indicates top of ridge.





A ginkgo sprout produced in fifth year after cutting of log. Foliage is vigorous, fully developed.

THE GINKGO

A Street Tree Today—A Hillculture Possibility of Tomorrow

By S. B. Detwiler¹

THERE is need to develop new uses for tilled lands which must be taken out of cultivation to control soil erosion. Such areas are best planted to trees. Often, however, the farm owner needs a larger and earlier return than can be secured from timber and as a consequence of this there is now interest in trees and shrubs which can be developed for special economic products, such as food, waxes, oils, and insecticides, or for high-priced specialty woods.

Ginkgo is but one of many perennial plants worthy of special study to determine their erosion-control and economic possibilities for annual production of new products from leaves and fruits, and having a value for specialty wood when the crop-bearing years are ended.

¹ Head, section of hill culture research, division of research, Soil Conservation Service, Washington, D. C.

The ginkgo or maidenhair-tree has the reputation of being more resistant to damage from insects and diseases than any other well-known shade or street tree. It is noted for its long life; the ability of ginkgo logs to produce vigorous water-sprouts 6 years after cutting is additional evidence of exceptional vitality in this tree.

Where the ginkgo trees grow on banks and slopes, the roots appear to hold the soil well, and this quality along with fairly rapid growth, freedom from pests, and hardiness as far north as eastern Massachusetts and central Michigan, indicates that it may have potential value as a specialty tree for erosion-control planting.

Ginkgo was introduced into the United States by William Robert Prince, son of the founder of the oldest nursery in America, established in 1737 at

Flushing, Long Island, N. Y. Between the close of the Revolutionary War and 1803, the Princes sought plants from every corner of America and Europe, and introduced nearly all of the Japanese trees we know, including ginkgo. The oldest ginkgo tree in the United States long shaded the old Prince homestead in Flushing. It came from Japan via England.

The curious leaves, odd fruit and individualistic branching habits of the ginkgo are so different from those of other trees of the yew family that its relationship to them is seldom suspected by the uninitiated. It has beautiful leaves resembling those of the maiden-hair fern but much larger in size. The chief use of the ginkgo in the United States has been as a specimen tree, planted by tree-lovers as a unique and picturesque botanical curiosity. It has not been used for forest and economic purposes.

In recent years it has been planted in Washington, D. C., and some other cities as a street tree. Much of its popularity for this purpose is due to the beauty of the famous avenue of ginkgo trees, planted about 1872, which led from the old red-brick Department of Agriculture building on the Mall to Constitution Avenue at Thirteenth Street, in Washington. A remnant of this beautiful avenue still remains, although most of the trees were cut in November 1931, preliminary to the leveling and formalized planting of the Mall between the Capitol and the Washington Monument.

The logs from these trees, about 50 in number, were piled high within a shed which has its sides open to free circulation of air, and they have not been disturbed since they were stored there in 1931. In 1935 one of these logs, separated from contact with the ground by intervening logs for a distance of 4 feet, sent up a vigorous sprout from its side. This sprout attained a length of over 2 feet by the end of 1935 growing season. In the same year another log in this pile produced a sprout over a foot long. J. Wise Byrnes, superintendent of greenhouses in the Bureau of Plant Industry, called the writer's attention to this interesting phenomenon and the logs were kept under observation.

Early in the 1936 growing season a log near the top of the pile and over 5 feet above the ground sent forth vigorous shoots at three different places along its side. One of these sprouts was photographed on July 13, 1936. Two other logs in the pile, one on the ground and one 6 feet above ground, produced similar sprouts in 1936. These were different logs from those which bore sprouts in 1935. In 1937 three other logs scattered through the pile in the shed again sent up

sprouts—6 years after the trees were felled. These were not so tall and vigorous as were the sprouts of the preceding year.

The retention of sufficient sap in the ginkgo logs to enable them to sprout in the sixth season after cutting, despite the fact that they were sheltered from rain over the entire period, indicates that the wood seasons very slowly. This also is shown by the absence of any large seasoning-checks at the ends of the logs. That there is considerable shrinkage of the wood during seasoning is well illustrated by a small cross-section of a log which was cut when the ginkgo trees were felled in November 1931, seasoned in a warm dry room for 6 months, and which since then has been on display in Mr. Byrnes' office. In expectation that the thin section of log would check and split, it was tightly encircled with an iron band after it had been dried out over winter. This precaution proved unnecessary. While a distance of approximately an inch now separates this iron band from the top of the log section, this decrease in size has come about so slowly that no checks have developed.

Dr. Woon Young Chun in his book, *Chinese Economic Trees*, states that "although generally regarded as native only in China, *Ginkgo biloba* is not now certainly known to be aboriginal or truly wild in any part of the country. It has been reported by Meyer as growing spontaneously in Chekiang Province, where it was cut for firewood, but others doubt it is truly spontaneous there. On account of sentimental attachments, the tree is not often cut down, and the wood therefore seldom finds its way in the market. The wood is soft, but straight grained, light brownish in color with a silky sheen. It is used for making abacus beads, seals, and other small fancy articles. In Japan it is extensively used for the ground work of the lacquer ware. The Japanese use the leaves for fertilizer, especially in rice fields under water. They ascribe to the leaves an insecticidal power. A leaf of the Ginkgo used as a bookmark will keep away insects that attack books."

The wood is entirely free from resin. It takes a smooth finish and polishes readily. The Chinese use this wood for carving, for which it appears to be as well adapted as sugar pine, a wood often used for this purpose. While apparently slightly harder than white pine wood, it has a fine, even grain that resembles "pumpkin" pine.

Lee B. Robertson, of Arlington, Va., made a test of ginkgo wood for pattern making and found it satisfactory for this purpose. He writes:

For 13 years I was a pattern maker at the United States Navy Yard at Washington, D. C., and am therefore familiar with the

common woods used in pattern making, mostly white pine, but also cherry and mahogany, and occasionally redwood. I consider white pine the best wood for patterns in the above list. Judgment must be based upon soft grain and easy working, freedom from shrinking and warping, smooth finish, and ability to hold well when glued and take shellac well. White pine represents the highest standard in all of these respects.

I made two patterns from the ginkgo wood; one was turned on a lathe and the other was all made by hand. This represents the two ways in which patterns are ordinarily made, and my object was to give this new wood a severe test. Except for a noticeable difference in odor of the wood and a slightly darker color, I found no difference in the ginkgo wood from that of the best white pine. Had I not been advised that I was working with a new kind of wood, I would not have suspected this wood was other than the white pine. Judging by this small but careful test, and based on my long experience with pattern-making woods, I consider the ginkgo wood fully equal to the white pine for this purpose.

Both the Chinese and Japanese grow the ginkgo for its seeds, esteemed by them as an appetizer and digestive aid or as a delicacy when lightly roasted. The seeds are sold in the markets of all Chinese towns and the meat resembles dried almonds except that it has a somewhat fishy flavor. In Japan, the seeds furnish an oil used for cooking and burning. It is probable that oriental markets would consume larger quantities of these seeds if they were obtainable, but the supply in China and Japan is limited.

The seed is the size of a large plum pit, with a thin shell. Its exterior is covered by a thick pulp having an aroma strongly offensive to American nostrils; the wood also has some of this unpleasant odor when freshly cut. The kernel is free of this odor and is rich in an oily substance which may possibly have commercial uses. It is reported that some of the workmen in Washington have suffered from swollen glands for several days after collecting the fruits from the trees on the Mall. This poisoning affects only certain individuals, as does poison ivy. Those who object to planting ginkgo trees on account of its fruits can plant grafted staminate trees, since this species is dioecious.

A search of Chinese literature disclosed a reference in the Chinese Encyclopedia of 1726 to the effect that the ginkgo was first entered as tribute in the Sung dynasty (A. D. 960-1271). The name then was changed to silver apricot but it was not used for medical purposes until about A. D. 1700, when "medical prescriptions sometimes use it. It can kill insects (worms?) and dispel poisons. If much is eaten it causes oppression and swelling."

Scientists regard ginkgo as the oldest genus of trees now surviving from past ages. Evidence of ginkgo trees has been found in rocks of the period (Permian) that followed the Coal Age, and in a later period

several species of ginkgo grew with *Liriodendron* and *Glyptostrobus* to form forests covering most of the Northern Hemisphere. Perhaps the ability of this tree to survive through the vast changes of long geologic ages, and its resistance to attack, are due to unsuspected chemical properties. Studies of the chemical and wood properties of ginkgo may prove productive.

In the Dutch East Indies a system of "bergculture" (hillculture) has been developed for annual production of specialty crops from trees and shrubs. Erosion is controlled and fertility of the soil built up under this system of maintaining natural and planted shrubby ground covers and leguminous trees which lightly shade and protect the crop trees. The latter are improved in quality and yield of products through breeding and selection, as in horticulture. The work of the section of hillculture research aims to develop erosion-resisting plants of economic value as an aid to the success of the national erosion-control program. This work is done in cooperation with the responsible Federal and State subject-matter agencies and aims to develop better erosion-control plants and their better use, including methods for a modified hillculture system adapted to conditions in the United States. This section encourages systematic cooperative studies of the ginkgo and similar erosion-resisting plants having potential economic value.

RAIN FELL IN ALABAMA

(Continued from p. 121)

above the terrace channel reduced the number of terrace breaks 66 percent on the 0- to 5-percent slopes, 43 percent on the 5- to 10-percent slopes, and 29 percent on the 10-percent and steeper slopes.

Likewise, vegetation above the terrace interval increased the average distance to the first break in the terraces 52 percent on the 0- to 5-percent slopes, 38 percent on the 5- to 10-percent slopes, and 9 percent on the slopes that were 10-percent and steeper.

After the rain farmers over the area seemed convinced that terracing alone would not control erosion. With one accord, the dozen or more farmers I talked with said they did not like strip cropping when they started it but that now they wish they had strip cropped more of their farms. Strip cropping in the area was done by terrace intervals, and possibly would have been even more effective had the strips been astride the terraces.

FRESNO TERRACES. *By Fred C. Newport*¹



Enrollees at Memphis C. C. C. camp demonstrate terrace construction with four-up team and a 5-foot fresno. They are using the "circle" system.

IN the United States, the application and efficient use of farm power and farm implements, supplemented by economic "dirt moving" machines, has been attempted by farmers in building soil conserving structures. The plow, the disk, the V-drag, the ditcher, the slip, and the grader, alone or in various combinations, have all contributed to the modern terrace construction of today.

The art of constructing terraces with a fresno is not new and seems to have wide application in certain portions of the Cotton Belt. Communities in Arkansas and Texas have used the fresno for the construction of satisfactory farm terraces. Especially is this true among owner-operators and renters who have had previous experience in moving dirt with this type of implement and who either keep hired help or do most of their own farm work. Many farmers find the fresno useful in constructing such additional farm improvements as (1) stock-watering places, (2) trench silos, (3) diversion structures, (4) levees, and (5) foundations for buildings. Sizes of fresnos adaptable to the power units used on the farm are procurable through local hardware dealers at small cost.

Fresno terracing may have evolved from the early use of fresnos to make fills in a bladed-terrace ridge. R. E. Dickson, superintendent of the experiment station at Spur, Tex., used fresnos to build his "sirup pan" system in 1926. The Soil Erosion Service built fresno terraces in Arkansas in 1934. The writer demonstrated fresno terraces in Hill County, Tex., from 1924 to 1934, and developed two systems of construction, the "figure 8" and the "circle" system. (See sketches.)

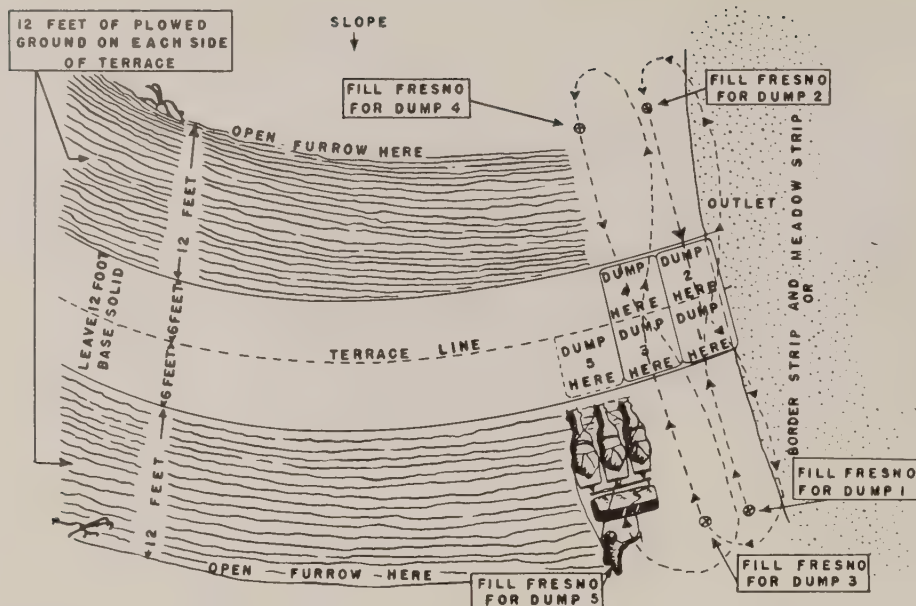
Tricks of the trade in constructing fresno terraces are:

1. Backfurrow two parallel strips the proper distance from each other to make the desired terrace base width. The plowed strips must be wide enough to fill the bowl of the fresno and push a little loose dirt in front of the cutting edge before it reaches the furrow at the border of the unplowed terrace core.
2. Drive at right angles across the plowed strips and load the fresno while approaching the unplowed strip. Loading on a circle may cause the traces or tugs to rub the hind legs of the team.
3. Unload the fresno on the same line at each side of the terrace core to make the curves smooth and the width uniform.
4. Dump each load of dirt snugly against the previous one and avoid gaps or low places in the ridge between dumps.
5. Set the fresno so that it loads and unloads easily—about the third hole from the bottom.
6. Dump the fresno while it is moving.
7. Plow the ground close enough to break up all land streaks. Remove stumps, boulders, and other obstacles on the strip to be fresnoed and thus avoid possible accidents.

Power and Labor Costs

Farmers who have built terraces with a fresno have estimated that a man with a team, plow, and fresno can complete as many hundred feet of terraces in a working day as there are feet of cutting edge on the fresno. Assuming that this estimate is approximately correct, one man with two good mules and a 30-inch fresno would complete 250 feet of terrace, while one man with four good mules and a 5-foot fresno would complete 500 feet of terrace daily. If the same terrace

¹Agronomist, Soil Conservation Service, Amarillo, Tex.



"Figure 8" system in diagram. Start plow 6 feet out from terrace line. Throw soil toward terrace line. Plow a strip 12 feet wide. Leave open furrow on outside of broken ground. Hook to fresno and start filling on the lower open furrow. Pull uphill straight across plowed ground and dump on lower side of unbroken strip (dump 1). Keep following the arrows. Mules always will be on solid ground when pulling uphill.

cross section, finished by contract with heavy equipment, cost \$30 a mile, the farmer could figure on about \$1.40 a day as wages for himself and two-mule team, or about \$2.80 a day for himself and four-mule team while terracing at home. In areas where large terrace cross sections are necessary, their construction with a fresno may require almost twice as much time.

The use of dual-purpose farm tractors will require three men to operate a fresno efficiently in terrace construction where the fields are large and smooth, one to drive the tractor and the other two to load and dump the fresno. With this type of construction a mile of terrace should be constructed in much less time. A well-organized tractor crew has been known to deliver a load of dirt into the terrace ridge in 15 seconds under favorable conditions. The crew was using an all-purpose farm tractor and a 4-foot fresno and following the "figure 8" system in sandy loam soil.

Two pieces of chain about 18 inches to 3 feet long, depending on the make of tractor, or two pieces of rod

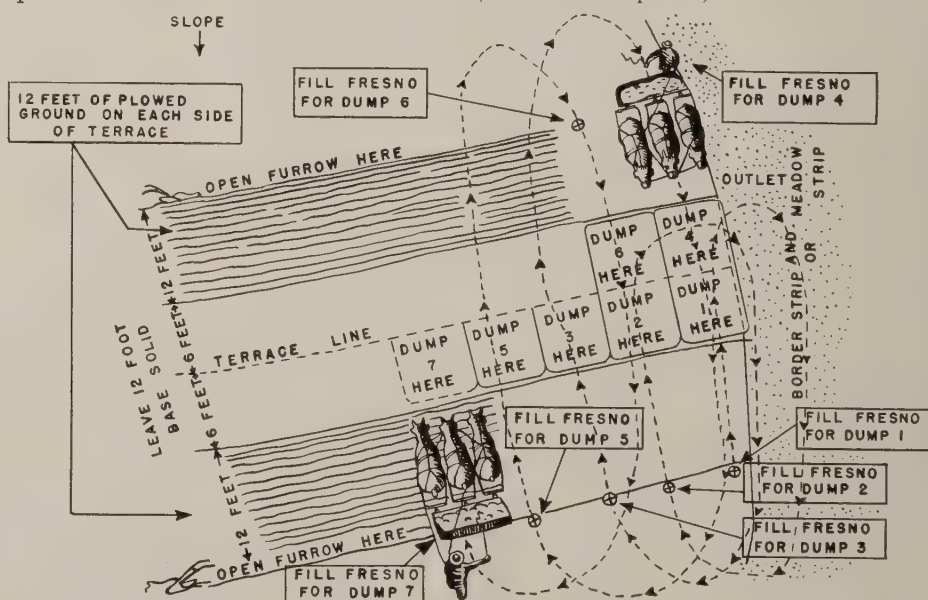
iron of similar length with an eye in each end, should connect each pull rod on the fresno with the drawbar of the tractor. This is to facilitate loading and unloading and to reduce the possibility of the Johnson bar striking the driver when the fresno is dumped. To ensure greater skill in operating the unit, the spliced pull rods should be fastened to the tractor drawbar about 6 inches closer together than the inside width of the fresno bowl.

Advantages of Fresno Terraces

The larger tractors with machines designed especially for terrace construction usually give the most economical results, but some farmers find it difficult to pay for terrace construction with this type of equipment. The main advantages of terrace construction with fresno scrapers are twofold: The farmer may use his own time, power, and equipment, and the cash outlay is small. If the farmer is willing to devote the extra

(Continued on p. 128)

"Circle system" in diagram. Start plow 6 feet from terrace line. Throw soil toward terrace line. Plow a strip 12 feet wide. Leave open furrow on outside edge of broken ground. Hook to fresno and start filling in on the lower open furrow. Pull uphill straight across plowed ground and dump on lower side of unbroken strip (dump 1). Keep following the arrows, continuing to circle to right, keeping lower side of terrace levee two dumps ahead of the upper side. Mules will be on solid ground when pulling uphill.





BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



TO HOLD THIS SOIL. By Russell Lord, Soil Conservation Service. United States Department of Agriculture Miscellaneous Publication No. 321. Washington, D. C. September 1938.

This book was written especially for the Soil Conservation Service and is intended for circulation throughout the Nation. Mr. Lord is a noted author and a fine writer—and he loves the land probably as few people love it. And furthermore he knows the land and he has at his fingertips many ingenious schemes of writing which he has used to give us the story as written “on the face of the earth,” of migration and land exploitation in this country. Most ingenious of all, Mr. Lord tells *from the beginning* what can be done and is being done to heal the scars of the progression of migrations. Conservation is woven into the tapestry of the story, for story it is, and after you have read it you will feel the scope of the problem as never before.

As this review is written the book is not many days off the press, yet already there is much enthusiastic talk about it from all sides. It is being stressed particularly as extremely important in the educational work of the Service: It should go into the schools; grade teachers should use it for background studies and in weaving soil conservation into nature studies, civics, and geography; high school students are going to read every word and then ask for more; economic geographers in colleges and universities will find concise information on every phase of the subject. All this, yes. And why not the land owners and farmers of the country? Who else but the people on the land, this very year and day, should have in their hands a book which gives so striking a picture, all of a piece, in an easy flowing style of writing, of their own country and their own farms? One can see the farmer and his family, under the lamplight of winter evenings, reading through from “The Film of Life” to the end of “Back of Yonder,” deeply interested and thoughtful. And then with a new dawn one can see that farmer family out in the field, in the orchard or the vineyard, or the potato patch, looking for the telltale signs, the rills, the bare slope, the silted corn patch, deciding then and there that something is going to be done about it.

The “Maryland window” turns out to be a device with inspiration behind it; for here we have a starting point—Russell Lord sitting at a window of his own farmhouse, gazing out upon his own and his neighbors’ fields—green fields and complacent people. They do not have accelerated erosion—so they think! But Russell Lord put on his hat and went out to see. He found silted streams and ponds. He found abandoned acres. And then he took trains or planes and went farther afield, very far afield, all over the United States; and now we have this book (written, most of it, between trips, at that Maryland window), giving the picture and the story of the whole broad sweep of the land as it suffered and winced under an unguided and slashing agriculture throughout the many years, and of that same broad land as it responds to farming practices designed to heal a badly scarred “film of life.”

The opening section of the book tells us the difference between geologic and accelerated erosion and why soils go dead under “man-handling.” Then, briefly, by means of the time-lapse camera device we are told the story of earth in the making, of balance by means of verdure and soil building, of animals crawling out of the sea on to the land, of man who came along “at noon on December 31st,”

of glaciers over the land and glaciers receding from the land. Then the picture of the continent as the white man found it—and we are ready to be told of land transformation, at the hand of the white man, during the last four or five seconds of the last day of earth’s 757-million-year year. Swiftly and brilliantly then the book moves onward to tell the tale of the exploitation of natural resources in the United States: Of the harvest of fish and fur in the Northeast; of the death of nine-tenths of the trees; of tobacco and cotton in the South and the loss of 7 to 15 inches of topsoil in the Piedmont; of burned-off second growth forest; of deficiency diseases of plants, animals, and even human beings. Is this the beginning of decadence? What else can it be—unless we bestir ourselves?

We then come to the “Wests,” and westward treks following “the way of the grass.” The people used up the East and went west to take the midlands, leaving in their wake ruined slopes and silted streams with here and there relics of futile and haphazard attempts at soil and water conservation.

And here we begin to encounter the wealth of historical information which helps to make a living book. Into the meadowy blue-grass country went the western migration; into the prairies; into the 700 million acres of the range. By 1830, three and a half million “Men of Western Waters” lived west of the eastern mountains. They used the natural resources with lavish waste and carelessness. Corn and hog, wheat, cotton, the railroads—what did it matter? The High Plains were there, farther west.

It is in this part of the book that the work of the Soil Conservation Service is definitely introduced. As the reader is guided along the roads of the Wests, he is told of practical methods that have been initiated and are now being forwarded in the attempt to undo the damage so that we may start all over again with new systems of land use and land management. The story of the beginnings of soil conservation is told by projects. We move about over the face of the country—from a “depletion experiment” in Ohio, across the Big River to Columbia, Mo., where the first erosion check plots were laid off on the slopes of the agricultural experiment station in 1917. Then we go into Iowa and learn what Jay N. Darling did about it after hearing Thomas McBride’s lectures. And then we come to the Big Creek watershed demonstration area at Bethany, Mo., one of the first in the Nation. The restoration of Coon Valley, on the driftless area of Wisconsin makes a moving story as told by Mr. Lord, “* * * where quail doubled and pheasants quadrupled in the first year of the project.”

The next West is the High Plains. And here is an extremely vivid word-picture of the taking of that vast land where rainfall is the most important thing in the world, where grass, if there is any, “hugs the soil.” Cattle and more cattle, sheep and more sheep; wounded grass; the plow in the Plains; free land, hardship and violence; wealth; the wheat rush in 1914—40 million acres added to the tilled domain; wheat surplus and a country turned upside down; dust storms, not lesser but greater. At this point Mr. Lord pauses in his story of migrations to tell us that wind erosion is spectacular when it kicks up dust storms, and floods when rivers get out of their banks; but steady persistent erosion, by water and by wind, through wrong land use, is most harmful of all. And that the great dust storm of May 11, 1934 served an invaluable purpose—“It jolted the United States awake to what is happening.”

As for westward migration, Mr. Lord strongly emphasizes what



BOOK REVIEWS AND ABSTRACTS

Continued



many of us know—it is still going on. Between 1930 and 1937, forty thousand families left the Plains for the Northwest, riding not in covered wagons but in rattling flivvers. They left the Great Plains “in bad shape,” needing new crops, grass, and more grass, new methods of farming to store the rainfall in the soil.

Then the “Last Wests.” This part of the book tells many a tale of the people. There is the story of the pioneer farmer-rancher in northern Colorado who is “tacking around cautiously from old-time ranching to putting up hay and laying in reserve feed * * * ‘Taking it along easy; that’s what does it. This speculation and plunging, it don’t count.’” And there are the farmers at the Mankato projects of the Service, out in Kansas: They had half ruined their land in 20 years and wanted to fix everything up in 20 months; they wanted something striking, and they got expensive broadbase terracing which woke them up to contours. One likes Russell Lord’s description of the agrostologists, with noses to the ground, knowing that “grass is immortal” if you know enough about it to appreciate it. But of course, “you can’t eat grass” as Mr. Lord reminds us; and he swings into the sorghum, strip-cropping, water spreading, rough cloddy cultivation theme and gives us extraordinarily human accounts of cautious, careful work at the dry-land experiment station at Hays, Kans., and of the Huron, S. Dak., farm-conservation project where the wind blows from this or that direc-

tion all the year round. The people are learning how to subdue erosion, to store water in the soil, to hold down their soil and at the same time raise crops so that they need not learn to eat grass—or dust. There is a great deal about dust in the “Last Wests” part of the book—and a very broad picture, too, of the work of the Soil Conservation Service in and around the Dust Bowl.

And then we come to “Back of Yonder”—the land of the Navajo, the Gila gone mad, the far shore where “irrigated citrus groves planted on contour terraces, and terraced, irrigated cropland in some of the fabled valleys of California are probably as little subject to erosion as farm land anywhere.” The end of the Oregon Trail is the end of “Back of Yonder” and out there at the very end of things they have learned how to control sand dunes with wheat straw “whiskers” and dunegrasses which “seem to resist any amount of adversity.”

In his very brief conclusion Mr. Lord tells us that “the idea of this publication is not to fix or to direct opinion but to arouse it.” In which case, the purpose of the book is fulfilled one thousand-fold. The pictures themselves tell a great story.

Mr. Lord’s significant new book “Behold Our Land,” the monthly selection of the Scientific Book Club, will be reviewed on this page in December.

Flood Control on Watersheds

The work of the soil conservation districts in erosion control is very closely and intimately related to the work which needs to be done on watersheds in aid of flood control, through run-off and water-flow retardation and soil erosion prevention. In fact, in many areas the measures which need to be taken for effective erosion control—terracing, contour farming, for-estation, seeding and planting of sloping lands to plants, trees, and grasses—are the identical measures needed to achieve “run-off and water-flow retardation and soil erosion prevention” in aid of flood control. It follows that, just as it has been found necessary to provide for the organization of soil conservation districts which can supplement and extend erosion control operations, so is it equally necessary for soil conservation districts to supplement and extend the work which the Department is authorized to do on watersheds in aid of flood control.—Statement by Secretary Wallace, October 29, 1938.

A technical article listed for December publication is Basil M. Bensin’s “Agroecology as a Basic Science of Soil Conservation.”

FRESNO TERRACES

(Continued from p. 126)

time required for fresno construction, he can secure satisfactory terraces. Any power available on the farm, such as steers, mules, horses, or small tractors, can be used in constructing fresno terraces.

This type of terrace construction has another advantage on farms where the available power and labor is not required during certain seasons. A more economical use of the farm power and labor can be secured by arranging the terrace construction work at a time when the available power would otherwise be idle. Greater use of animal power on farms also encourages the use of a larger acreage of erosion-resisting feed crops and this usually results in better soil-conservation practices.

WILLOWS FOR STREAMBANK CONTROL

(Continued from p. 111)

banks shade the water, tending to lower the temperature and to increase fish food, and also furnish splendid coverts and travel lanes for wildlife. These advantages together with the fact that willow matting has been used successfully at a cost that compares favorably with other types of protection, should earn for it wider consideration.

New Bulletins That Have Bearing on Conservation Problems

For **REFERENCE**
Compiled
by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Survey of Lake Eldorado, Eldorado, Kansas. (In cooperation with the Kansas Agricultural Experiment Station.) April 20-May 8, 1937. mm. SCS-SS-25. July 1938.¹

Advance Report on the Sedimentation Survey of Lake Olathe, Olathe, Kansas. (In cooperation with the Kansas Agricultural Experiment Station.) May 26-June 4, 1937. mm. SCS-SS-24. July 1938.¹

Office of Information, U. S. Department of Agriculture

Selecting Fertilizers. Bureau of Chemistry and Soils. Circular 487. August 1938.

Legumes in Soil Conservation Practices. Soil Conservation Service. Leaflet 163. 1938.

Erosion on Roads and Adjacent Lands. Soil Conservation Service. Leaflet 164. September 1938.

Soil-Depleting, Soil-Conserving, and Soil-Building Crops. Soil Conservation Service. Leaflet 165. September 1938.

Native Woody Plants of the United States: Their Erosion-Control and Wildlife Values. Soil Conservation Service. Miscellaneous Publication 303. June 1938. \$1.75.²

To Hold This Soil. Soil Conservation Service. Miscellaneous Publication 321. August 1938.

Agricultural Experiment Stations

Experiments with Grass Hay. Bulletin 306. Agricultural Experiment Station, Durham, N. H. 1938.

Farm Practices and Their Effects on Farm Earnings. Bulletin 444. Agricultural Experiment Station, Urbana, Ill. August 1938.

Fifty Years in the Service of Agriculture, 1888-1938. Bulletin 397. Agricultural Experiment Station, Columbia, Mo. June 21, 1938.

Magnesium as a Factor in Nitrogen Fixation by Soybeans. Research Bulletin 288. Agricultural Experiment Station, Columbia, Mo. 1938.

The Planting Value of Oats and Barley Collected from Farmers' Drills and Granaries. Bulletin 681. Agricultural Experiment Station, Geneva, N. Y. 1938.

Preliminary Pasture Clover Studies. Bulletin 325. Agricultural Experiment Station, Gainesville, Fla. September 1938.

Preliminary Report on Inheritance of Differential Ability of Inbred Lines of Sudan Grass to Produce HCN. Technical Bulletin 24. Colorado Experiment Station, Fort Collins, Colo. April 1938.

Relative Productivity of Soils in Arkansas. Bulletin 365. Agricultural Experiment Station, Fayetteville, Ark. 1938.

Rural Land Use Activities in Missouri. Bulletin 399. Agricultural Experiment Station, Columbia, Mo. July 1938.

Seasonal Changes in the Chemical Composition of Some Arizona Range Grasses. Technical Bulletin 73. Agricultural Experiment Station, Tucson, Ariz. June 15, 1938.

Soil Management and Fertilization for Tobacco. Bulletin 379. Agricultural Experiment Station, Lexington, Ky. April 1938.

Soils in Relation to Fruit Growing in New York: Part XII, Tree Behavior on Important Soil Profiles in the Peru, Plattsburg, and Crown Point Areas in Clinton and Essex Counties. Bulletin 705. Cornell Agricultural Experiment Station, Ithaca, N. Y. 1938.

Some Profile Characteristics of the Pine-Growing Soils of the Coastal-Plain Region of Arkansas. Bulletin 361. Agricultural Experiment Station, Fayetteville, Ark. June 1938.

Survival of Several Alfalfa Varieties Seeded on Irrigated Land Infested with Bacterial Wilt. Technical Bulletin 23. Colorado Experiment Station, Fort Collins, Colo. April 1938.

Terracing, an Important Step in Erosion Control. Bulletin 400. Agricultural Experiment Station, Columbia, Mo. July 1938.

Type of Farming and Ranching Areas in Wyoming. Bulletin 228. Agricultural Experiment Station, Laramie, Wyo., in cooperation with the U. S. Department of Agriculture Bureau of Agricultural Economics. July 1938.

Miscellaneous

Agricultural Statistics, 1938. U. S. Department of Agriculture. 1938. 55¢, paper cover.²

Brome Grass for Erosion Control. Extension Circular 119. Agricultural College Extension Service, University of Nebraska, Lincoln, Nebr., in cooperation with the U. S. Department of Agriculture. June 1938.

Dixon Springs Land Utilization Project. Bureau of Agricultural Economics. 1938.

A Hand Book of Agronomy. Bulletin 97. Extension Agronomy Department, Virginia A. & M. College and Polytechnic Institute, Blacksburg, Va., in cooperation with the U. S. Department of Agriculture. Revised July 1938.

Legume and Grass Silage. Bulletin 391. New York State College of Agriculture, Cornell University, Ithaca, N. Y. May 1938.

Range Lands of Northeastern Nevada: Their Proper and Profitable Use. (A Progress Report.) U. S. Department of Agriculture, U. S. Department of the Interior, Farm Credit Administration Federal Land Bank of Berkeley, and the University of Nevada. June 1938. mm.

Report on the Agricultural Experiment Stations, 1937. Office of Experiment Stations, U. S. Department of Agriculture. July 1938. 25¢.²

Soils and Men. Yearbook of Agriculture, 1938. U. S. Department of Agriculture. 1938. \$1.75 (velum cover).²

Southeastern Idaho Land Utilization Project. Bureau of Agricultural Economics. 1938.

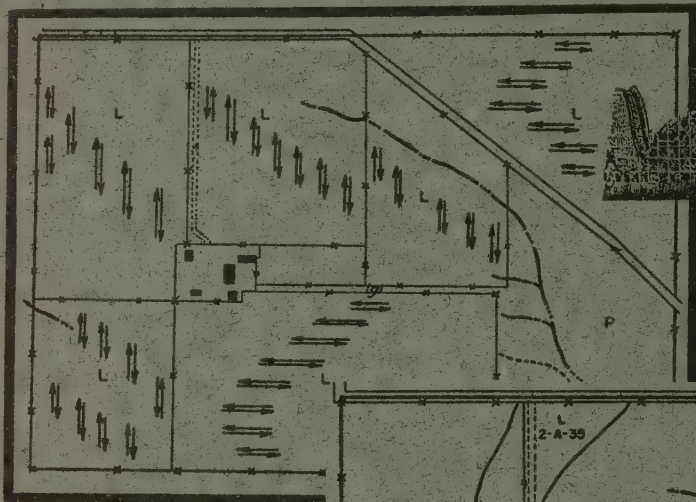
¹ Issued for use by Soil Conservation Service staff and cooperating officials only.

² From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

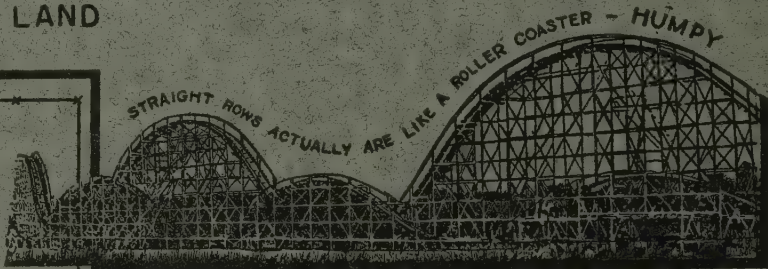
MAPPING A FARM

FOR CORRECT LAND USE

OLD SQUARE FARMING ON SLOPING LAND

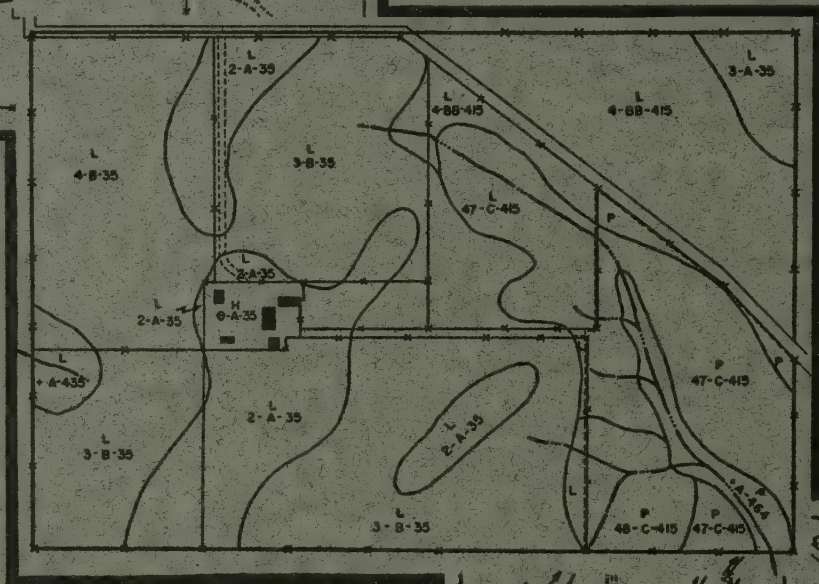


STRAIGHT ROWS ACTUALLY ARE LIKE A ROLLER COASTER - HUMPY

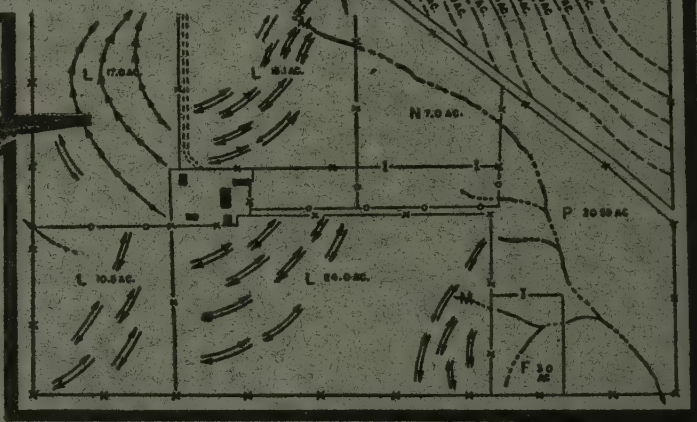


MAPPING
SOIL TYPES, SLOPE,
EROSION AND
LAND USE.

THE
LAND
INVENTORY



A black and white photograph showing a field with contour rows. The rows are curved, following the natural slope of the land. The text "CONTOUR ROWS ARE LIKE A RAILWAY CURVED BUT LEVEL" is overlaid on the image, following the curve of the rows. The image is part of a larger document, with other text visible in the background.



NEW CONTOUR FARMING

LEGEND

LAND USE: L-ROTATION FIELDS OR STRIPS P-PASTURE N-PERMANENT ALFALFA M-SODDED WATERWAY F-NEW FOREST PLANTING H-HOMESTEAD

G-GULLIED AREA X X PRESENT FENCES -|- NEW FENCES -o- OLD FENCES REMOVED + / DIRECTION OF ROWS FOR CULTIVATION ↘ TERRACES

EROSION: +-ACCUMULATION 2-SLIGHT SHEET EROSION (0-25% SURFACE SOIL LOST) 3-MODERATE SHEET EROSION (25-50% SURFACE SOIL LOST)

4-SEVERE SHEET EROSION (75-100% SURFACE SOIL LOST) 7-OCCASIONAL GULLIES 8-FREQUENT GULLIES 0-UNCLASSIFIED

SLOPE: A-0-1½% B-1½-5% BB-5-10% C-10-20% D-20+%

SOILS : 35-MIAMI SILT LOAM 415-HILLSDALE LOAM 435- ECHO LOAM 464-EEL LOAM

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



DECEMBER
1938

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WELLINGTON BRINK
EDITOR

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SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. IV • NO. 6



H. H. BENNETT
Chief, Soil Conservation Service

DECEMBER • 1938

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Up-and-down plowing increases draft of tools, invites soil losses. A year after this picture, the same Missouri farmer, disking over-the-hill with a tractor, found he must keep to low gear. He experimented with a horizontal route, discovered no need to shift from "high." Convinced of the advantages of contour operations, he has since farmed strictly on the level.

A Time Study of Contouring and Straight Farming

By Kenneth P. Zunkel¹

EARLY in the history of the Big Creek demonstration project at Bethany, Mo., farmers objected to contouring, contour strip cropping, and contouring with terraces. They insisted that these practices would require too much time for farming operations, and in those days the technical men had no data with which to overcome their objections. To meet this deficiency, a time survey was made (in 1935-37) to

measure the amount of time required to perform identical operations on contoured, contour-terraced, and straight-farmed fields, using implements of uniform size in all cases. It was realized that there would be many factors to consider—degree of slope, soil type, length of rows, machinery size and power, and the operator himself, whose degree of efficiency might affect the amount of time it took to perform a particular operation on any field. It proved impossible, how-

¹ Junior conservationist, Soil Conservation Service, Bethany, Mo.

Table 1.—Time required per acre for farming a straight-farmed and a contour-terraced field of corn

Operation	Tool used	Straight-terraced field, 10 acres, 6-percent rough slope. Average length of rows, 40 rods			Contour-terraced field, 5 acres, 4- percent gentle slope. Average length of rows, 30 rods		
		Man time	Horse time	Tractor time	Man time	Horse time	Tractor time
		Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.
Plowing.....	14" gang.....	1 30	.....	1 30	1 12	.....	1 12
Disking.....	7' tandem.....	30	.....	30	30	.....	30
Disking.....	7' tandem.....	.....	.....	.....	30	.....	30
Planting.....	2-row, 2-horse.....	1 00	2 00	.....	1 12	2 24	.....
Harrowing ¹	8', 2-horse.....	30	1 00	.....	.....	.....	.....
Rotary hoeing.....	2-row, 3-horse.....	48	2 24	.....	48	2 24	.....
First cultivating.....	1-row, riding.....	1 48	3 36	.....	2 00	4 00	.....
Total time required per acre (harrowing omitted) ¹		5 36	8 00	2 00	6 12	8 48	2 12

¹ The harrowing was not included in totals which compare identical field operations. It was necessary because of erosion, and was done for the purpose of filling small trickle gullies not found in the terraced field.

ever, to measure the effects of relationships of all these factors, and in the end the information obtained was analyzed according to the size of machinery used.

In the survey, records were taken on 87 straight-farmed fields with a total of 1,216 acres, on 82 contour-farmed fields with a total of 1,010 acres, and on 33 terraced fields with a total of 383 acres. A man-time rating and a power-time rating were given to the three different methods of farming according to the length of time required for each particular operation. A summary of the records showed very little difference in the man-time rating between heavy-draft machinery (plowing and disking) and light-draft machinery (harrowing, planting, and cultivating). The average horsepower used in heavy-draft operations was 3.3 on straight-farmed fields, 3.2 on contoured fields, and 3.2 on terraced fields. The average horsepower used in light-draft operations was 2.4 on straight fields, 2.3 on contoured fields, and 2.3 on terraced fields.

A tabulation of the samples of data, based on the kind of operation and size of machinery used, and also based only on the kind of operation disregarding the size of the machinery used, indicates that in most cases straight farming required the least amount of time per acre, contour farming more time, and contour farming with terraces the longest time per acre.

Of all the factors mentioned (size of machinery, degree of slope, heavy or light-draft machinery, length of rows, and average unit of power used) no one factor seemed to be outstanding as causing the difference in amount of time required for a given operation. Perhaps a bigger factor than any of these was the newness of the method to the operator. As yet, no way has been found to measure this factor under actual farming conditions.

The following comparisons were taken from four fields on the same farm in the watershed. The two fields in each comparison were as nearly equal as any fields that could be found. The operator never had

seen any contour farming until 1934 and was in doubt as to the practicability of the new methods but was willing to try them. The records covered the first year of his experience with contour farming, and by the end of the year he was quite enthusiastic about all three phases—contouring, contour strip cropping, and contouring with terraces. In table 1 comparisons are shown between two fields, one a straight-tilled unterraced field of 10 acres and the other a terraced field of 5 acres farmed on the contour. These two fields were farmed by the same individual. The same implements and power were used although the contour terraced field required an extra disking because of wet ground.

The terraced field required 36 minutes more man time, 48 minutes more horse time, and 12 minutes more tractor time for the same operations per acre. Allowing 25 cents per man-hour, 10 cents per horse-hour, and 80 cents per tractor-hour, the additional cost of contour farming with terraces was 39 cents for the same operations but only 16½ cents if the additional harrowing is included.

Table 2 compares the results obtained on the same farm where operations were identical on a contoured strip-cropped field of 9.2 acres and on a 6-acre straight-farmed field.

The time records on these particular fields, with identical operations, showed that it required 1 hour 25 minutes less man time, 3 hours 54 minutes less horse time, and 6 minutes less tractor time per acre on the contour strip-cropped field.

Using the same rates for man, horse, and tractor time as in discussing table 1, the difference in cost would mean a saving of 82 cents per acre for contouring under these particular conditions. If the additional harrowing of the straight-farmed field is included, the additional cost rises to \$1.05 when farming straight.

It will be noticed that in both tables an additional harrowing was necessary, on the straight-farmed fields,

Table 2.—Time required per acre for farming a straight and a contour strip-cropped field of corn

Operation	Tool used	Straight-terraced field, 6 acres, 5-percent uniform slope. Average length of rows 80 rods			Contour strip-cropped field, 9.2 acres, 3-percent uniform slope. Average length of rows 90 rods		
		Man time	Horse time	Tractor time	Man time	Horse time	Tractor time
		Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.
Plowing.....	14" gang.....	1 30	.....	1 30	1 31	.....	1 31
Disking.....	7' tandem.....	1 40	.....	40	33	.....	33
Harrowing.....	8', 4-horse.....	1 00	4 00	.....	33	2 12	.....
Planting.....	2-row, 2-horse.....	1 00	2 00	.....	46	1 32	.....
Harrowing ¹	8', 2-horse.....	30	1 00	.....	.....	.....	.....
Rotary hoeing.....	2-row, 3-horse.....	1 00	3 00	.....	38	1 54	.....
First cultivating.....	1-row, riding.....	2 00	4 00	.....	1 44	3 28	.....
Total time required per acre (harrowing omitted) ¹		7 10	13 00	2 10	5 45	9 06	2 04

¹ The additional harrowing is not included in totals which compare identical field operations. It was necessary because of erosion, and was done for the purpose of filling small trickle gullies not found in the strip-cropped fields.

Table 3.—Comparison of average time, per acre, of tillage and planting operations for corn, using the most popular sized machines found in the study

Operation	Tool used	Straight-farmed		Contoured		Terraced	
		Man time	Horse time	Man time	Horse time	Man time	Horse time
		Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.
Plowing.....	16".....	3 40	11 16	3 55	11 58	3 46	11 39
Harrowing.....	10'.....	34	1 31	37	1 28	38	1 25
Disking.....	8'.....	41	2 38	45	2 26	44	2 35
Planting.....	2-row.....	49	1 38	50	1 41	53	1 47
First cultivating.....	1-row.....	1 33	3 6	1 37	3 13	1 46	3 31
Second cultivating.....	do.....	1 25	2 50	1 25	2 50	1 35	3 10
Third cultivating.....	do.....	1 23	2 46	1 17	2 34	1 31	3 2
Total.....	.....	10 5	25 45	10 26	26 10	10 53	27 9

to fill small trickle gullies not found in the terraced or contour strip-cropped fields. Heavy rains came shortly after planting, in both instances, making the additional harrowing necessary.

While the figures from these particular fields have some value, the comparison of time on a greater number of operations would indicate what is to be expected on the average.

Table 3 gives the amount of time required per acre, with the most popular machines used, and based on the average figures obtained in this study.

While the total time required for these tools appears logical, a few irregularities occurred. A comparison of total figures is similar to that found for other tools in the study but not included in table 3. In comparing contour-with-terrace farming with straight farming, the difference in time was only 48 minutes of man time and 1 hour 24 minutes of horse time for all tillage and planting operations. The difference between the extremes of the three methods of farming was so small as to be negligible in determining which method to use.

THE *Largest* BIG PLOW

By Harry H. Hyatt¹

SHADES of Paul Bunyan! Nothing like this Gargantuan machine has been seen since that mythical deity of the lumbermen dug the Grand Canyon using his Blue Ox as motive power. This final specimen in a series of plows² built by two enterprising southern

Californians turns a furrow 6 feet in depth. Other plows in the series turn furrows 2 feet deep and 4 feet deep.

These plows were devised for three purposes: (1) The reclamation of good agricultural land that has been buried under a deposit of sand brought in by flood waters, (2) the elimination of morning glory or other

¹ Section of information, Soil Conservation Service, Santa Paula, Calif.

² Turning the Earth Upside Down With a 4-Foot Plow. Soil Conservation, December 1936, p. 123.



Looking Backward Toward the Share. Six-foot Wheels Support the Plow Beam.

noxious weeds by burying them deep enough in the soil to kill them, and (3) the rejuvenation of some of the alluvial and recently deposited soils.

In reclaiming land the plow turns over the sand deposits and fertile soil that has been buried, so that the sand is below and the good soil again in its former position on top. This is accomplished by the plow through an ingenious arrangement. An adjustable blade is mounted on the front of the big plow. This blade scoops the sand down into the gigantic furrow made during the previous passage of the plow. Then, the big plowshare comes along and turns up the old-soil on top of the sand.

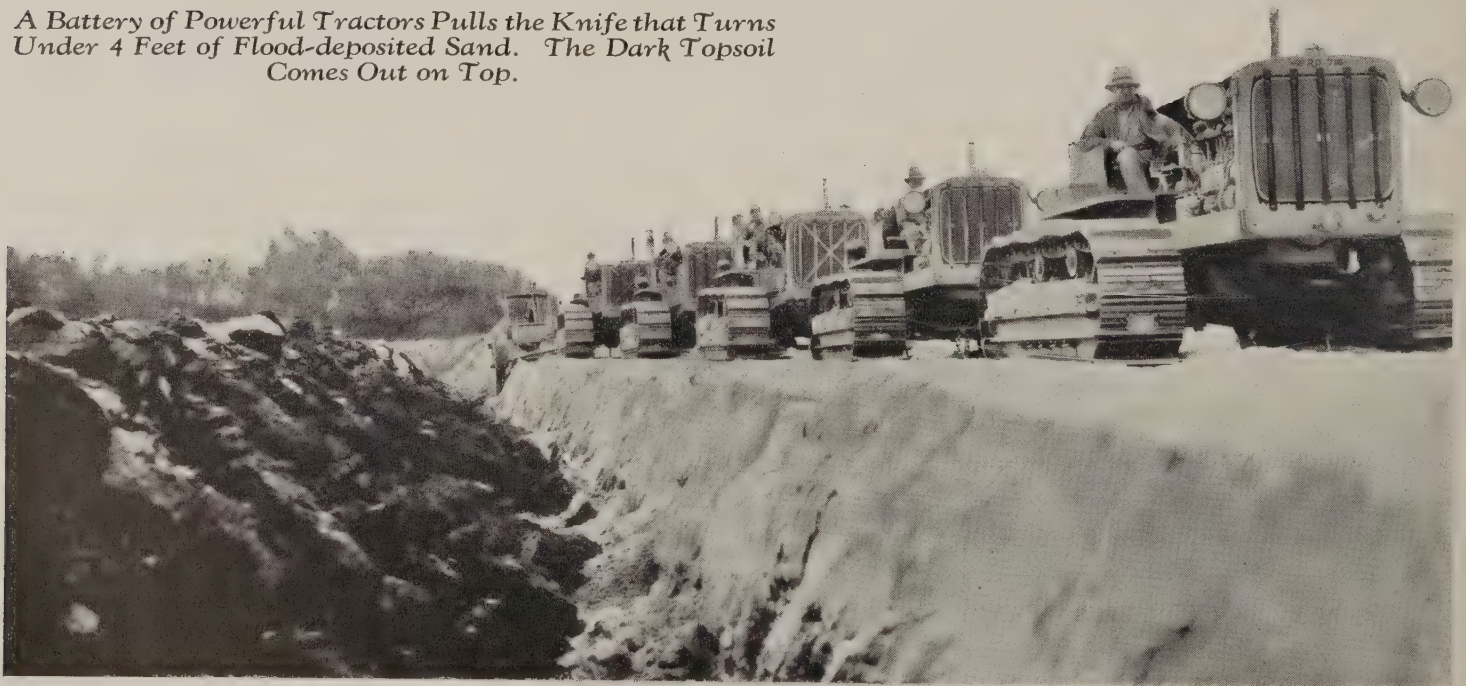
In the rejuvenation of some alluvial soils, it has been found that the plow works satisfactorily where the soils have a uniform and deep profile. Continuous cropping may have exhausted the plant nutrients from the top 1 foot or 18 inches of soil. Turning 2 or 3 feet of this soil upside down brings new and fertile soil to the surface. It must be emphasized that this latter process can be carried on only in certain kinds of soil.

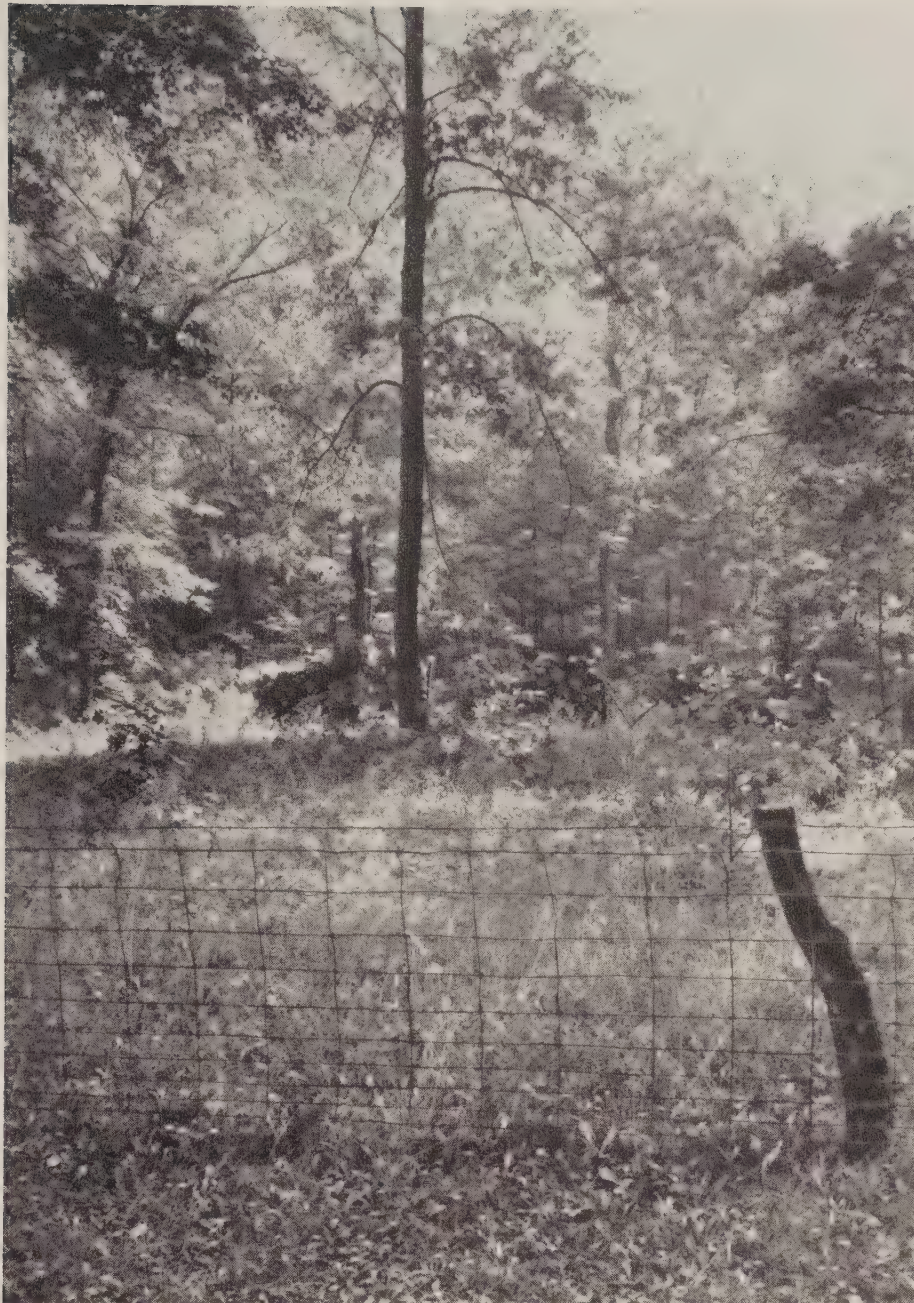
The largest of the plows has two wheels 6 feet in height, is operated by a hydraulic hoist, will bury as much as 4½ feet of sand, and weighs 7 tons. When the going gets tough, it requires five tractors with an aggregate of 400 horsepower to pull it.

About 2,000 acres of land in Orange County, Calif., were deep plowed in 1937; and considering the sand deposits left by the flood of March 2, 1938, that acreage will probably be doubled this year.

This ingenious device is another proof that scientific man can and will keep ahead of adversity.

A Battery of Powerful Tractors Pulls the Knife that Turns Under 4 Feet of Flood-deposited Sand. The Dark Topsoil Comes Out on Top.





Fencing is but One Essential in Intelligent Management.

A Fence Around the Farm Woodland

By John F. Preston¹

IS IT sufficient from the standpoint of soil conservation to build a fence around the farm woodland which will exclude the grazing of domestic animals? Perhaps we should state the question a little more broadly and ask, is there sufficient justification from the standpoint of erosion control to do more than take the initial steps necessary to protect the farm wood-

land from fire and grazing? A correct answer to this question is more important now that we are working with farmers in the soil conservation districts than it was when we were purely on a demonstration basis.

To arrive at a correct answer makes it necessary to consider the background of the farm woodland; to consider the basic agricultural philosophy which has been in the minds of farmers and agricultural workers ever since the first settlers cut farms out of the wilder-

¹ Head, section of woodland management, Soil Conservation Service, Washington, D. C.



The Best Removed, Only the Poorest Left—an Application of the "Ground Line" Philosophy. (Photo U. S. Forest Service.)

ness. One has only to review our agricultural literature to realize what is implied in this statement. It is full of such terms as cultivated land and pasture land; crops and livestock; soil-building and soil-depleting crops; clean-tilled crops, small grains, hay, and pasture; and again such terms as cash crops and other crops. By cash crops is meant wheat, corn, cotton, tobacco; and by other crops is usually meant feed for livestock.

It is very rare that analyses of the farm income include any place for recording income from the woods. In the lexicon of most agricultural economists, the words "wood products" are ordinarily not found. All of this is in spite of the fact that more than 15 percent of the total farm area in the United States is in some sort of woods cover; that 25 percent of the farm area east of the Mississippi River is in woodland; and over 40 percent of the area of the average farm in the South and in the Northeast is in woods. All of this in spite of the fact that the 1930 census shows a revenue of 242 million dollars received by the farmers from their woodlands. The amount per farm was, according to the census, \$81 in 1909, \$217 in 1919, \$95 in 1929, and \$77 in 1934. Such revenue has come from a neglected, uncared for, untilled, and unappreciated wild land crop. These census figures for woods income contain no estimate of, or calculation for, the value of things which are associated with the woods, such as wildlife, recreation, beauty, sentiment; these are intangibles, and as such they are beyond the category of the economist.

Of course, a very potent reason for neglect of this item by the agricultural economist is that the average revenue per farm received from woodlands is relatively small as compared to other crops, but this is not surprising in view of the lack of care and attention given to the average woodland and the lack of recognition which the farm woods has received as a part of the agricultural economy. The census figures for 1935

show 185 million acres in farm woods, and 60 percent of this is reported as grazed woodland. An unknown but appreciable part is burned over every year.

Agriculture is governed by a ground line philosophy. This is a natural and logical development, because most farm crops—crops to be harvested annually—are adapted to the plan of cutting off at the ground line that which the soil produces. When the crop is harvested, only the soil plus the crop residue is left. The farmer clears off the residue either by burning or by plowing under; he starts the next crop from seed or perennial roots. It is not surprising to find that many farm woods are what foresters call "coppice woods" which means that the existing woods have come from sprouts. Coppice woods are produced by clean cutting just as a crop of asparagus is cut; the next crop is allowed to spring from the roots of the trees removed.

This sort of woods management is in keeping with the ground line philosophy of agriculture, but it is poor forestry. It produces very little revenue, and it is usually the wrong practice from the standpoint of silviculture, and silviculture is what makes a good paying forest. Foresters know that this ground line philosophy applied to the management of farm woodlands is wrong, and that it should be changed, and agricultural workers in the Soil Conservation Service know that this philosophy is wrong. Fortunately, more and more farmers who are cooperating with the Soil Conservation Service now share another viewpoint. They have a different philosophy represented by two objectives which the Soil Conservation Service uses: Every acre of land must be treated in accordance with its needs and adaptabilities; and, every part of the farm must produce its share of the farm income.

In view of this farmer and agricultural philosophy which is the background of our agricultural history, a fence around the farm woodland is not sufficient for erosion control. It is not a sufficient means of making

the farm woodland produce its share of the farm income. A ground line philosophy is absolutely inconsistent with profitable forestry, and it does not result in an erosion-resistant vegetation. Why? Because a clean-cut woods or a woods clean cut from the standpoint of commercially valuable trees, creates temporary waste. The values are gone. There is no visible value left even though such a cut-over woods may have a potential value. Even the most optimistic forester cannot assign very much tangible value to a new slashing. Such a woods, without an appreciation of its potentialities, without a realization that eventually it will produce more as woods than in any other crop, will surely be neglected. It will be grazed and it will be burned.

Many farmers who protect their woodlands from fire and domestic animals ruin them by neglect, or what amounts to the same thing—injudicious cutting. A good woods can soon be converted into an economic desert of worthless species by the application of the axe guided by a ground-line philosophy. Fire, grazing, and neglect are the three horsemen which ride roughshod through the farm woods, and a sufficient explanation of why they ride and ruin is this ground-line agricultural philosophy. The farm woodland, to be useful as an erosion-control measure, requires more than a fence around it, more than fire protection. It requires the exclusion of the three horsemen. A fence doesn't stop them, but a fence plus a satisfactory income from the woods will keep them out. And a satisfactory income from the woods can be brought about only by the intelligent application of silviculture as one of the tools of the agriculturist.

Let us not deceive ourselves into thinking that we have accomplished something for erosion control when

we have built a fence and a fire line around the woods. That is the first step, but it is only the first step. Having done that, the forester is in a position to show the farmer the possibilities of silviculture and what it can do as a part of agricultural practice. The capital stock in the farm woods is the soil plus the growing stock. The soil is the crumbly, porous, water receptive floor of a woodland free from fire and trampling stock. The growing stock is made up of a whole galaxy of trees from seedlings to mature trees ready to cut. Only proper management of these two elements will enable a farm woodland to meet its share of the farm income and thereby earn the right to a permanent place in the land-use program of the farm.

Very few farms in the timbered country can produce a satisfactory standard of living for the farmer without his getting a proportionate share of income from the woods. Soil plus growing stock plus management are the three factors which must be recognized as determining the success of the farm woodland as an erosion-control agent. We must get the farmer to abandon the ground line philosophy as applied to the woods; he must raise his sight from the ground to diameter breast high. A fence around the farm woodland is not a guarantee of permanent land use. Fire, grazing, and neglect can be overcome only by manipulation of the three factors—soil, growing stock, management. The ground line philosophy must give way to "woods appreciation."

In an article on stimulation of hardwood cuttings by means of synthetic growth substances, V. T. Stoutemyer states that "the cuttings should be made of firm, well ripened wood, and, with some subjects, preferably of a somewhat larger diameter than that often used."

Soil, Plus Growing Stock, Plus Management.





THE USES OF MULCH

By C. R. Enlow¹

This Oregon Prune Orchard Sleeps Undisturbed Under a Protective Blanket of Straw. A Hint of What Can Happen When the Soil is Left Bare is Given at the Right of the Picture, Where Washing is Taking Advantage of the Lack of Cover.

THE opportunities for using mulch on the farm in connection with erosion control are numerous. In some sections of the country many farmers in past years have mulched orchards and vineyards with straw, hay, and other materials in the attempt to improve the organic content of the soil. During the past few years, with the advent of a soil-conservation program, interest in mulch has increased; this is true particularly in those areas where it is difficult to grow vegetation that will afford erosion control and soil improvement, such as old orchards or groves, or where competition for moisture makes it difficult to grow a cover crop without reducing the production of the cash crop. The production of grapes without irrigation in California affords an illustration of the latter.

Frequently the mulch crop is grown and not harvested, but is allowed to remain on the land for pro-

tection against erosion. Oats, barley, Sudan grass, or other nonhardy annuals planted in late summer will make fairly good growth before being killed by winter freezes. Such material offers good protection against winter erosion and has the advantage of being anchored to the soil so that it is not washed or blown away. The dead plants do not offer competition for moisture in early spring, but instead help to retain it for use by the main crop grown on the land during the summer. This practice is often followed in the vineyards and berry patches of Michigan.

In humid sections most farmers recognize the advantage of mulch in establishing grass, legumes, or other erosion-control vegetation on eroded slopes, in gullies, on galled spots in pastures, and under other conditions where moisture conservation is important. A light mulch over a seeding of grass prevents the seed from washing away and retains the moisture until the seed has germinated and the grass plants are well established. Straw, manure, legume hay

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of no economic value, or even weeds or brush can be used.

In semiarid regions a mulch of wheat stubble, Sudan grass, millet, or similar plant residue gives excellent protection to grass seedlings. The limited moisture supply is retained to aid germination; destruction by soil blowing is avoided; winter snow is retained; summer soil temperatures are lowered; and conditions in general are made more ideal for growing grass. Merely drilling grass seed in wheat stubble, where moisture is plentiful and weeds are not too abundant, is an excellent method of seeding. The rod weeder may be used to destroy weeds and keep the plant residue on the surface; this will provide mulch that is so essential to the successful establishment of grass.

Many citrus groves in California are mulched by the simple method of mowing the weeds and grasses that grow in the groves and leaving the mowings on the ground to protect the soil from erosion and aid in conserving moisture. Olive groves grown without irrigation are always a problem from the erosion-control standpoint. This is because of the sparse cover growing under the trees. They can be handled very successfully, however, if mulching materials are available. Fruit growers in Michigan are hauling mulch many miles for use in their orchards; and New Jersey orchardists mow salt grass from marshy flats to use in protecting the highly erodible soils on which their fruit trees grow.

Frequently, in order to dispose of the water from terraces, it is necessary to use terrace outlets or waterways almost immediately after construction. It is true that the newly prepared outlets may be covered with sod and thus satisfactorily protected against erosion; but the operation is expensive, and sometimes sod cannot be obtained. Seeding and covering with mulch is less expensive, although it is necessary to protect the mulch with chicken wire until the vegetation has become established.

If all our soils had the proper physical structure and were high in organic matter, it should not be necessary to resort to the use of mulch to protect them. Yet, invariably, the production of specialized crops almost prohibits the use of a soil-conserving rotation. When these crops are grown on sloping land and clean cultivation is practiced to control weeds and check the evaporation of soil moisture the soil is exposed and very vulnerable to sudden dashing rains; in such instances all possible methods of saving the soil must be employed.

While mulching has excellent erosion-control possibilities, the danger of spreading plant diseases, or

harboring insect pests and rodents through its use should be investigated before the practice is advocated on a wide scale. It is recommended, therefore, that the assistance of the State experiment station authorities be solicited in order to avoid any complicating problems that might arise from our efforts to control soil erosion.

The following excerpt from an article by Kramer and Weaver² illustrates admirably the value of mulch in conserving soil and water:

"The wonders worked by litter are indeed remarkable. On a barren soil where the upper 6 inches had been washed away, 41 pounds of oven-dry forest litter were placed over 36 square feet of soil. Although this material could hold but .35 inch of rain when fully saturated, yet it reduced rainfall runoff from 36.6 percent (control plot) to 16.2 percent of the total 55 inches precipitation. The greatest reduction in runoff occurred when the rains were hardest and the most water fell. Erosion was reduced from 70.5 lbs. to only .84 lb. per acre (Meginnis, '35). Thus the capacity of litter to absorb rainfall is of little consequence compared with its power to bring about absorption of water by the soil. This is accomplished largely by keeping the soil pores from becoming clogged by silt particles being thrown into suspension, as regularly occurs when heavy rains beat upon bare soil. Weeds are not harvested except in times of great distress. They remain on and in the soil. They function during life and after death."

Kramer and Weaver continue, quoting Seitz,³ in an effective two-paragraph discussion of weeds and topsoil:

"Weeds are the wound dressers of the soil. Whenever man or nature makes a scar, the vigorous, coarse-fibered weeds find the spot and straightway mend the injury. Hated and much objurgated, the weed, of whatever breed, is one of the most useful forces in nature. The farmer regards it as a foe, the gardener as a nuisance. In truth, it is a friend that persists, regardless of ill treatment and attempts at extirpation. Soil, to preserve its strength, must be protected with some sort of covering, otherwise the rains leach it, or wash away the precious particles of mold that make it productive. Man neglects this factor in his dealing with the earth. . . . great damage results, and much more would follow but for the energy of the weed family."

² Joseph Kramer and J. E. Weaver, Relative Efficiency of Roots and Tops of Plants in Protecting the Soil from Erosion. Bulletin 12, Conservation Department of the Conservation and Survey Division, University of Nebraska. January 1936.

³ D. C. Seitz: Weeds—Nature's Wound Dressers. Outlook, Nov. 24, 1926, p. 405.

Agroecology as a Basic Science of Soil Conservation

By Basil M. Bensin¹

AGROECOLOGY is the applied ecology of agriculture. It may be applied to economic plants (plant agroecology), and it may also be applied to the study of farm animals (animal agroecology).

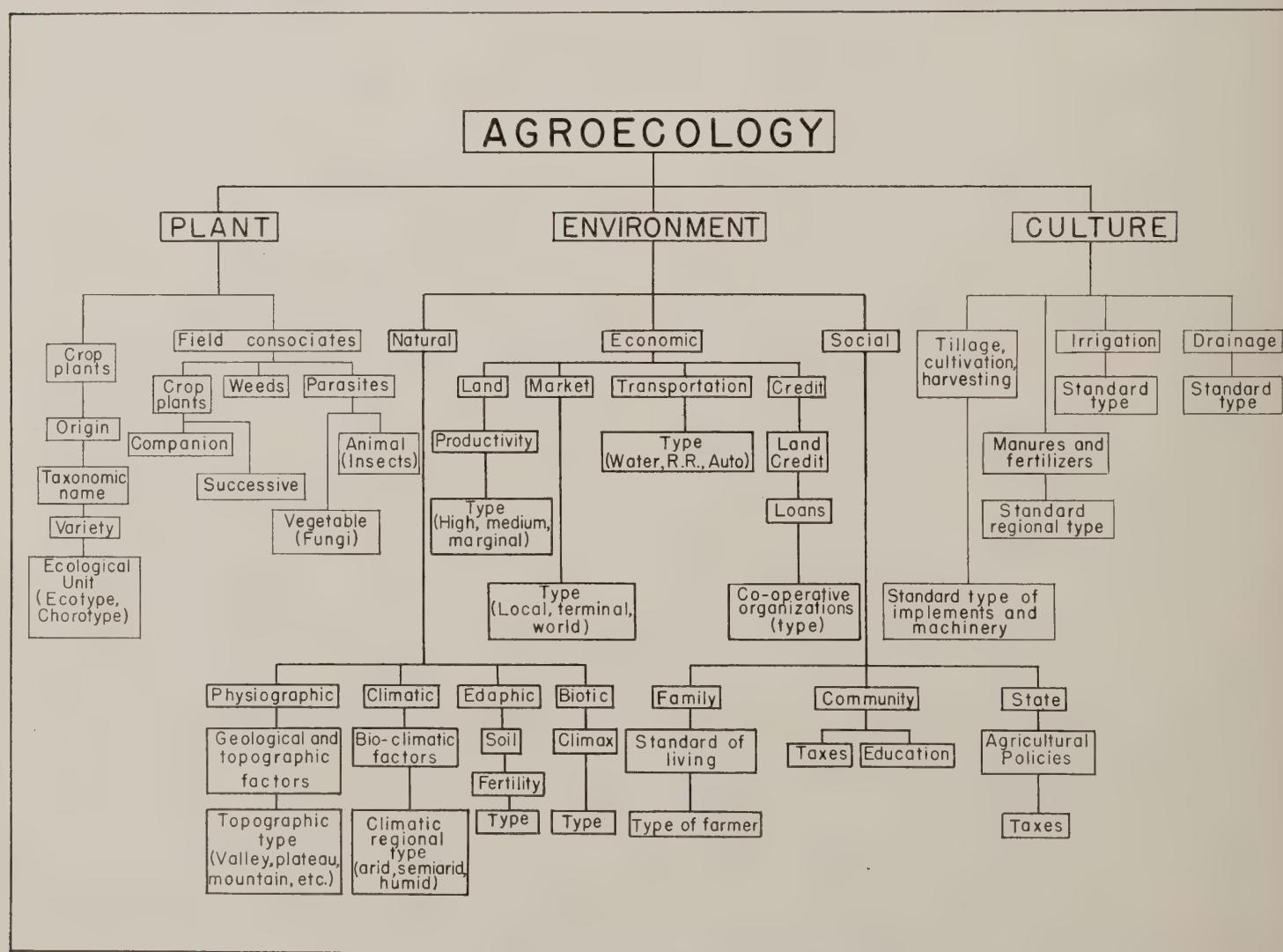
The term "agroecology" was first proposed to the Czechoslovak Botanical Society and to the International Plant Breeders Association at Prague in 1928 and then to the International Agricultural Congress at Bucharest in 1929. The objective of agroecology as a basic part of agronomy is to analyze relationships between species and types of crop plants and their environment. There are three main phases to be considered: (1) Crop plants and their regional types,

¹ Dr. Bensin, a graduate of the University of Minnesota, has a varied experience which includes agricultural explorations in Central Asia and Mexico. This paper was suggested by a lecture which he recently delivered to the Graduate School, U. S. Department of Agriculture, Washington, D. C.

(2) regional environment as it affects crop plants, and (3) culture as the dynamic factor in agroecology, comprising the agrotechnique of the region.

Plant ecology in a broad sense is usually defined as the science of the relationship of plants to their environment. In the early stages of development of plant ecology (about 1895), it dealt chiefly with observation and description of plant societies of various geographical regions. Plant ecology has gradually developed into the experimental science of the inter-relations of plants and their environment.

Ecological research designates definite ecological types of plants in their relation to their environment as ecads (Clements 1908), ecotypes (Turesson 1922), climotypes (Rosanoff 1928), and chorotypes (Bensin 1928). The last mentioned term indicates regional



ecological types. In each region there are some dominant plant societies, which give a characteristic feature to the landscape of the region and which are designated as climaxes of it. In the relation to widely different geographical regions, those ecological types of plants of the same species but with distinct and characteristic features of successful adaptation to environment have been designated as geographical races (Komarov 1901) and geo-ecotypes (Gregor 1933).

Complete agroecological studies should include not only natural but also economic and social elements of agricultural environment as significant factors for agricultural production. Agroecology deals with definite regional types of farm plants and animals, types of farmers, types of farming, and types of implements and machinery used. Hence, regionality is a basis for agroecological studies. The agricultural region (*agrochora*) comprises the complex of environmental factors affecting agricultural production, agro-technique, and regional types of economic plants (*agrochorotypes*).

Analytical agroecology includes both qualitative and quantitative analyses of the crop plants of the region. Qualitative agroecological analysis consists of the systematic studies by means of field observation of and experiments with the *agrochorotypes* of crop plants. It leads to ecological diagnosis of crop-plant factors as found through detailed studies of the origin, taxonomy, genetics, anatomy, cytology, and physiology of the crop vegetation in its relation to environment, as well as rhythm of growth (phenology) and productivity (yield). This diagnosis needs to evaluate all parts of the plant—stem, leaves, branches, and roots, as well as flowers and fruits—in relation to productivity and the specific factors affecting growth and yield in the region. Therefore, agroecological diagnosis is more complex than taxonomic description and requires experimental test. It also includes the evaluation of ecotypes, the study and classification of which has become one of the important phases of experimental taxonomy. Likewise, qualitative agroecological analysis, based upon diagnoses of many agroecotypes of our cultivated and native economic plants, should give the most valuable material for comparative studies and for establishing the ecological classification of our regional varieties and ecological types of crop plants.

Quantitative Agroecological Analysis comprises frequency of analyzed and described regional types in a certain geographical and agricultural region in its relation to that of other crops and varieties grown there. Technically this frequency is in some cases revealed

by crop statistics and acreage of arable land of the region. In other cases the ecologist must use his own judgment. In this connection, we should emphasize the significance of consociation. According to my conception the term “consociation” designates in a broad sense all living organisms, plants, and animals found on the same field, including companion and successive crops planted by farmers, weeds, and parasitic fungi and bacteria living on the plant or in the soil. Presence of the last-mentioned has quite a decisive effect upon agricultural production.

Crop rotation systems really indicate agroecological plant succession, planned by the farmer according to proper agricultural production and marketing in the region and on a given farm. The prevailing regional type of agrotechnique, as well as the type of farmer himself, his personality, education, energy, character, and even specific features of the race to which he belongs, should be considered as an essential factor of agriculture.

Determination of edaphic factors (soil) is essential to a study of plant relations to the soil and requires a series of special ecological investigations. It naturally involves detailed analysis of physical and chemical properties of soil (edaphology). Another agroecological phase of investigation includes experimentation with perennial crop plants to find a properly balanced ecological mixture in plantations. This fundamental ecological principle already has been applied in silviculture in many countries with apparent success. Likewise, ecological principles of plant competition, succession, and plant climaxes should be considered with special reference to the soil conservation problems of various regions. Standard grass mixtures for ground cover composition should be established only after a proper agroecological analysis. Tests of new introduced plants should be arranged in various regions to determine the degree of ecological adaptation which they may possess before the actual introduction and recommendation to the farmer.

The experimental methods of agroecological research should be based upon statistical analysis of field observations with special reference to correlations noted in the ecotypes, including correlations for all parts of typical plants. Problems of soil conservation require close study of the ecotypes of soil-holding and soil-building plants. Such studies of ecotypes are of special value to the development of soil conservation and hill-culture in this country.

The most distinctive ecotypes appear in tropical countries where polymorphic character of plants is quite common. In my studies of the vegetation of

northern Mexico, I discovered some striking ecotypes among the native plants of the semiarid region of the northern part of the Soto la Marina River Valley, in the State of Tamaulipas. Within a short distance from the shore of the Gulf of Mexico there are great changes in the physiognomy of vegetation. Here within a small area, ecotypes of open valley, hill, and coastal plain regions are modified as to height, general appearance, and adaptation to the microclimatic conditions. I noted ecotypes of *Randia aculeata* L. (synonym: *Randia mitis* L.), *Cordia Boissieri* DC., *Leucophyllum frutescens*, I. M. Johnston, and *Karwinskia Humboldtiana*, which may have significance as soil-holding plants adapted to certain types of soil. *Randia aculeata* (Syn. *R. mitis*) shows distinctive ecotypes: (1) aborescens, (2) erecta, (3) prostrata.

Randia, of the family Rubiaceae, is a common coastal plant throughout the West Indies and in southern Florida. In Puerto Rico, according to Britton and Wilson, it is a vigorously branched shrub 1 to 3 meters tall, or may become a small tree of 10 meters. In Bermuda it is a shrub only, and 1 to 3 meters tall. Standley, who studied the trees and shrubs of Mexico particularly, refers to it as a shrub 1 to 3 meters high. Tree forms of *Randia aculeata* L. (synonym, *Randia mitis* L.) are characteristic of the open-valley chorotype. *Randia aculeata* (syn. *Randia mitis*) is a dwarf shrub in upland hills, and grows prostrate and cushion-like along the sea coast in Soto la Marina region.

Similarly, *Cordia Boissieri* is tree-like in the river valleys, a high bush in open valleys, and a dwarf bush on the coastal plain. *Karwinskia Humboldtiana* is a high bush in the valleys and a dwarf bush with somewhat reduced leaflets on the coastal plain. *Leucophyllum frutescens* is 2 to 3 meters high on the open valleys and 35 to 50 centimeters on the coastal plain. Thus chorotypes as ecological units correspond to so-called "geographical races" of the same species found under various latitudes and sometimes distinguished as taxonomic subspecies.

Ceniza, *Leucophyllum frutescens* (Berl.) I. M. Johnston, of Scrophulariaceae is a highly adapted xerophyte, with whitish pubescent obovate leaves and pink flowers, and should be considered as a most typical element of all xerophyte formations of this region. It is a shrub varying in height from 50 centimeters to 2.5 meters. In this low plateau region it is not more than 1 meter high, always growing as a dominant in the societies where it appears, and always indicating calcareous soils.

Cordia Boissieri, commonly called "Anacahuita" in Mexico, belongs to the Boraginaceae, and is quite a

popular shrub among the natives. It is very handsome, especially when covered with white flowers, somewhat resembling the *Rhododendron* in appearance. All parts of the tree are aromatic. A jelly made from the fruit is much used as a remedy for lung diseases, coughs, and colds. A decoction of the leaves is a popular domestic remedy for rheumatism, and is generally employed in the treatment of bronchial infections. The leaves are oblong, cordate at base; flowers in small dense cymes; fruit ovoid 2.5 to 3 centimeters long, reddish brown, and shining, the flesh sweet and edible, but if eaten raw, it is said to cause dizziness, as if one were intoxicated. The wood is used for making yokes. This plant is well adapted to various soils of the region, but in Mexico it is polymorphic, varying in its form, as Standley states, from a tree 8 meters high, with the trunk 20 centimeters in diameter, to a small bush, found among other xerophytic shrubs.

Biological Principles of Agroecology

The general principles of agroecology are the same as those of general biology. In my mind the fundamental principle of ecology is a law of interchangeable or mobile equilibrium, stated as a natural philosophical principle by Herbert Spencer, and later proved and developed in experimental biology and formulated by two Russian biologists, A. Elenkin and A. P. Iljinsky (1921).

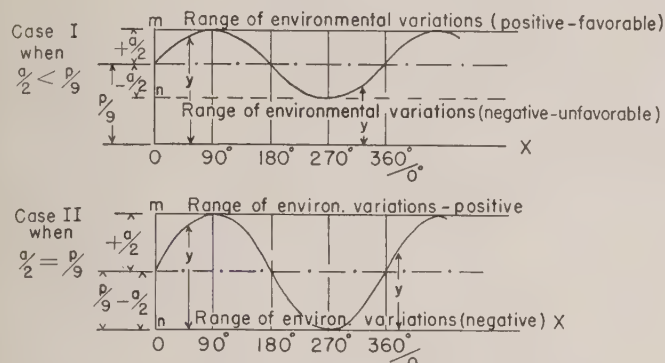
According to Spencer, the life of the organisms consists in maintaining *mobile equilibrium*—a balancing between external and internal factors, a continued adaptation of internal relations to external, or a mechanical reciprocity between the organism and the environment. The principle of equilibrium may be applied in physics and chemistry as well as in biology. An example in physics is seen when *force*, *motion*, and *gravity* are related. Ordinary scales are the very best instruments for demonstrations of equilibrium, as while we are weighing some substance and gradually obtaining the balance of both pans with the amplitude of motion equal to zero.

In chemistry every chemical reaction is designated as an equation with two balanced parts on both sides of the equation—chemical equilibrium. Likewise we have electrical equilibrium in electric generation.

The Russian biologist Elenkin dealing with symbiotic phenomena in the life of lichens, arrived at definite conclusions about the relation between certain organisms and their environment. He developed formulae representing the fundamental interdependence of the organisms of the same community, and showed that

Biological Law of mobile Equilibrium applied to the adaptation of ecotype to environment.

Ecotype or Chorotype (P_g) in its development depends upon positive (favorable) or negative (unfavorable) environmental conditions.



- The line of mobile Equilibrium follows a Sinusoid with its origin at $y = P_g$, $x = 0$ - within range $m \pm n = a$
- Ordinate „y“ $= P_g + \frac{a}{2} \sin x$ is the distance from axis of abscissas Ox up to the line of mobile Equilibrium and represents the chances or frequency for existence of the chorotype.
- „P“ is the sum of beneficial hereditary potentialities manifested in the chorotype.
- „a“ is environment limiting the potentialities „P“ of the chorotype.
- „P_g“ is the chorotype best adapted ecotype to the regional environment.
- „a“ is the amplitude or magnitude of variations of environment favorable or unfavorable (positive or negative) for existence of the chorotype.
- Angle „x“ is the function of time in the cycle of environmental variations for a certain period of the life of the ecotype.
- We see in Case II at abscissa 270° the chorotype is driven out of existence.

the community relationship of two or more organisms is in mobile equilibrium, dependent upon the external factors of environment (light, temperature, humidity, and chemical elements). Elenkin's formulae provide a basis for a law of mobile equilibrium as applied to biology.

Ecology deals with the best adapted regional types of vegetation, designated by various authors in different ways: *geographical species* (Komarow, 1901), *subspecies* (Wettstein, 1898), the *ecad* (Clements, 1908), *habitat type* or *ecotype* (Turesson, 1922), the *modification-variety* (Koso-Poljansky, 1920), *clymotype* (Rosanof, 1928), *chorotype* (Bensin, 1928), *agroecotype* (Gregor, 1933).

The idea of the chorotype as a fundamental concept in agroecology is based upon Elenkin's biological law of mobile equilibrium. Even if the agrochorotypes are geographically distant, corresponding to *geographical races* of Komarow and *geocotypes* of Gregor (1933), they can be transferred to similar agrochora and tested. This test would show capacity for establishment in a plant population or survival in an extreme habitat.

Each chorotype should be carefully described with reference to its behavior to the environment and its

morphological and anatomical features. Such experimental tests may indicate cytological differences in its chromosome constitutions, as it has been shown in *Phleum pratense* (Gregor and Sansome 1930).

In my opinion we should describe the noted character of all vegetative organs as *modifications* (designated sometimes as continued modifications) as follows: The plasticity of various plants grown under different environmental conditions as a result of their reaction to an environment may be different, some species being *monotypic*, *oligotypic*, *polytypic*. Another principle, which can be considered as a basic fact in ecological studies, is *periodicity* among the species of the same genus. Periodicity has been designated by Komarov (1908) as a series of the species closely related genetically. Later this idea was developed by Vavilov (1922) who stated the so-called *law of homological series*, not only for the closely allied species but also for related genera. The principle of periodicity in biology is logically the same as in chemistry, where periodical systems of elements were established much earlier by Mendeleev (1869) and now are universally accepted. These concepts as applied to agroecology show that *agrochorotypes* of farm crops are very closely related to taxonomy, plant physiology, and genetics.

The third principle used in agroecology is *correlation*. This, in a broad sense, has been applied as a logical principle, introduced by Quivier and later by Radl (1901), for parallel studies of two fluctuating factors, closely related but remaining independent, which are without clear interaction. Besides this, there is some organic and functional relationship between the parts of an organism which are clearly dependable one upon another, that is, in close correlation (*epharmony*). *Epharmony* really is an indication of the state of the equilibrium within the chorotype of single function and development of plant organs and, as a result, a certain adaptation of these, as a definite characteristic feature of the vegetative organs, is observed.

In the case of unusual conditions unfavorable to the struggle for existence, there arises a special kind of adaptation as a result of *epharmonic convergency* which is very significant for the life and character of the best adapted individuals and strains. This should be the object of special attention and study by agroecologists in such cases as dry season or winds affecting growth and development of crop plants. Those plants remaining after a period of such unfavorable conditions of growth should be used as valuable material for

(Continued on p. 152)

Kudzu Repairs Erosion-Torn Areas In South

By A. T. Semple¹

ON a recent trip to several of our project and camp areas in Georgia, Alabama, and Mississippi, I was very much impressed with the value of kudzu for erosion control. The emphasis which R. Y. Bailey, now regional agronomist, placed on the use of this plant, starting on the Dadeville project in 1934 and spreading to most of the region, has paid big dividends.

Kudzu has a peculiar capacity for completely covering and stabilizing gullies, galled areas, highway and railway cuts and fills, ditch banks, and terrace outlets. Apparently it has no close competitors in this field. Its valuable place in perennial strips in the Southeast is described in Farmers' Bulletin No. 1776, Strip Cropping for Soil Conservation.

Speaking in round numbers, Mr. Sloan, manager of the Greenville, Ala., project, made a statement to the effect that the most severe erosion on most farms occurs on about 10 percent of the area. This applies to the average farm of less than 100 acres with as much as 25 to 50 percent of the area in woodland, some bottomland pasture, and the balance principally corn and cotton land, with the steeper slopes of the hillsides abandoned to a scant growth of such plants as pine, persimmon, broomsedge, poor joe, and aristida, with considerable areas entirely bare. Gullies in these areas cut back rapidly into the better lands above and dump silt to bury the better soils in the bottoms. Thus the meager areas of productive soil are whittled away, and the operators approach complete dependence on other sources of income than the farms they live on.

With a cash and labor outlay considerably less than that made on average cropland, these abandoned areas which would do well to produce 5 bushels of corn per acre, can be made to produce 1 to 1½ tons per acre of excellent kudzu hay. Considering the low income of such farms, the possibilities of marketing such hay immediately come to mind, but other aspects of the situation point strongly to the importance of home consumption.

Like tomatoes, sweetclover, and other now valuable crops, kudzu has had to overcome a lot of prejudices and misunderstandings. A proposal made several

years ago that series of parallel wire fences be erected to serve as trellises for kudzu and provide grazing for cows seemed almost ridiculous at that time.

I was of the opinion that mowing kudzu and making it into hay would be a rather difficult and disagreeable job and that most farmers would not be bothered with it. And so I was delighted with the quantities of baled and stacked kudzu hay of excellent quality which I saw on the Anniston and Dadeville projects. In several places haymaking was under way. It is easier to cure and no more difficult to handle than a heavy growth of red clover, according to my experience. One farmer's enthusiasm over his kudzu crop beat anything of its kind that I had ever seen. As proof that kudzu haymaking is no flash in the pan, I should like to tell more than is possible within this space, particularly about 800 acres of kudzu meadows between Wetumpka and Montgomery, Ala. This is part of a commercial mixed-feed enterprise, which was started with 60 acres of kudzu in an abandoned pecan orchard. The one thing here that should be emphasized is that rotary hay loaders would not do the work. But when some fork-type hay loaders were located and put on the job, there was no more trouble. Incidentally, the rate of growth and appearance of pecan trees is very noticeably improved in contrast to exactly similar trees which have not had the benefit of kudzu.

Twenty years ago Charles F. Leach, of Monticello, Fla., was extolling the value of kudzu. Unfortunately, too little attention was paid to what he had to say. At that time the emphasis was being placed on the introduction of purebred livestock in the South, especially in areas which previously had been freed of splenic (Texas) fever ticks. Far too little attention was paid to the necessity of providing this stock with sufficient feed of adequate quality. Consequently, they failed to produce profitably, in some cases not at all, and the great majority of farmers have gone ahead depending almost entirely on cotton and other annual crops as their main source of income.

As a result, next to pasture, hay has been one of the scarcest and most expensive products on most southern farms. Now that it has been found practical to produce hay from perennial legumes on land that formerly

¹ Assistant head, agronomy and range management section, Soil Conservation Service, Washington, D. C.



Kudzu Hay Cures Quickly, Can be Baled from the Field and Handled Easily with a Fork. If a Hay Loader is Used, it Should be of the Fork Type.

was less than worthless, it will be possible to do away with the laborious practice of fodder pulling and the soil-depleting practice of growing annual legumes such as soybeans and cowpeas for hay. Their removal for hay leaves the soil poorer than it was before. In addition, the soil humus is destroyed, the ground is left bare in the process of seedbed preparation, and there is scant cover after the hay crop is taken off. As these annual hay crops usually follow oats, they can be replaced with lespedeza or other summer-growing vegetation which does not necessitate working the soil, which gives it adequate cover throughout the season, and which may be plowed under to improve the cropland preferably after being grown on the land for at least 2 years. Phosphate must be used to provide for a satisfactory growth of lespedeza.

With this inexpensive hay from former waste land and with enough bottomland pasture to carry a couple of cows and supply the workstock with cheap forage about two-thirds of the year, the farmers will be relieved of certain needs for cash expenditures and will have provision for a better living for their families. Thus they will be in a better position to carry out an adequate program of soil conservation. Consequently,

I feel that every reasonable effort should be made to induce the greatest possible number of farmers in the Southeast to grow kudzu. In addition to planting gullies and galled areas in the most favorable spots, with ample provision for fertilization and cultivation, during the first year or two terrace outlets and other drainageways requiring perennial cover should be selected for kudzu—this in order that 2 or 3 acres of this valuable legume hay may be planted on the average farm.

Within 3 years, the farmers will be able to cut hay from their kudzu patches, will be convinced of its value, will have a source of crowns for planting the other areas needing such treatment, and will be ready for other steps in a complete erosion-control and proper land-use program.

Grover F. Brown, regional agronomist, Region 1, notes that saltgrass hay, washed on to New Jersey beaches by wave action during storms, is proving a source of fine quality mulch for orchards and vineyards. The mulching practice is being carefully studied and it is believed that it will play an important role in erosion control on the sandy soils of fruit-producing areas.

"BEFORE AND AFTER" ON AN OHIO DEMONSTRATION FARM

By F. E. Charles¹

IN November 1936 the Soil Conservation Service, cooperating with the Ohio Agricultural Extension Service, set out to carry soil conservation practices to southeastern Ohio farmers outside project and camp areas. Farmers were demanding help, partly, no doubt, because they had read and heard much of erosion control work. To meet the situation, R. L. Bazler, soil conservationist, was delegated by the Service to replan those farms recommended by the Agricultural Extension Service and the county land-planning committee.

Fifty-three farms in a score of southeastern Ohio counties have been completely replanned for soil conservation. The 53 farms have a total area of 8,746 acres. The revised plans provide for cultivation on 2,885 acres. This cropland in proportion to entire farm acreage would not seem large in Iowa, Illinois, or Kansas. But southeastern Ohio is an area of sharply rolling topography where slopes commonly run up to 30 percent, with considerable untillable land on the steep slopes and sharp breaks. Prevailing soil types are highly erodible. Needless to say, erosion is serious on cultivated fields and overgrazed, mismanaged pastures.

Strip cropping has been considered one of the most suitable soil-saving practices for this section. For a generation or more, a few far-seeing farmers have been following a system of strip cropping, but until recently most of their neighbors have failed to see its advantages.

As evidence of the current swing to this method of conservation farming, Mr. Bazler tells us that of the 2,885 acres of cropland in the 53 replanned farms 2,408 acres are to be strip cropped—1,008 acres already are being farmed by the strip-crop system. The 477 acres of cropland not scheduled for such treatment is bottom-land or flat land on which strip cropping is unnecessary.

Other major land-use changes planned on the 53 farms include the following: 643 acres, formerly used for cropland, are to be used only for permanent pasture; 253 acres are reserved for permanent meadow; 57 acres are set aside for reforestation; 117 acres of former pasture will be returned to forest; and a total of 906 acres of woodland will be fenced and protected from grazing by livestock.

It is obvious that the farms have been carefully selected by the Agricultural Extension Service. This is how it works:

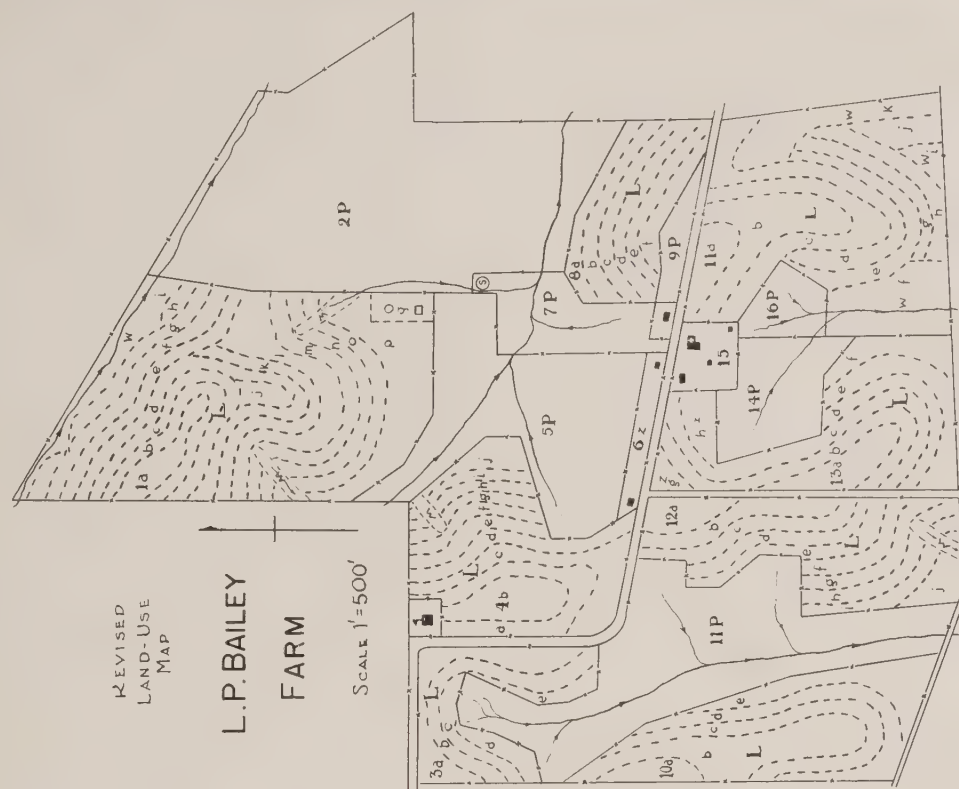
Farmers ask the county agent for help on their erosion problems. The county agent studies the farms and the farmers, and determines whether satisfactory demonstrations can be developed. Farms must be typical of the area, located prominently, and suitable for demonstrating several practices. Farmers are informed in detail of the responsibilities involved. If it appears that a demonstration can be made on a farm, the county agent obtains information on previous land usage, the existing cropping plan, farm manure and fertilizer previously used, liming practices, livestock on the farm, and so on. He then consults the county land-use committeemen for final approval. A request is then made, through the extension soil conservationist, for the assistance of a project technician in planning the farm.

With the counsel of the county agent and Agricultural Extension Service specialist, the technician replans the farm. That is his sole responsibility, except for a reasonable amount of "follow up" to assist the farmer in developing the plan.

To see how the demonstration farm plan works out in actual practice, let us consider a typical example, the Bailey farm of Tacoma, Belmont County. Here is one of the better and larger farms in the community—250 acres. Once owned and managed by the late L. P. Bailey, prominent Jersey cattle breeder and master farmer, this farm has been something of a model for its neighbors. It is accustomed to serving as an example. It was purchased in 1886 by the elder Bailey and has been a dairy farm for many years. Much against his wishes, but because his wife insisted, L. P. Bailey traded a thresher for a Jersey cow and calf and a bull. From that the Bailey herd has grown to 100 head, with 50 cows in the milking herd.

For 30 years L. P. Bailey's Jerseys grazed the farm extensively; hay and concentrated feed were purchased. Then came the war and high prices. Everyone, including the Baileys, broke up sod to produce grain. Even after the war, with prices still high, they continued to farm the place intensively. "We had to do it, because we couldn't afford to buy high-priced

¹ Regional information officer, Soil Conservation Service, Dayton, Ohio.



...SYMBOLS...

P- Pasture
W- Woods
Z- Truck
--- Buildings
--- Fences
X Idle
= Roads
Arabic numerals - field numbers Small letters - Field division numbers

L- Cultivated land (Strip cropped)
M- Sod waterways
O- Orchards
--- Field boundary
⊙ Spring
⊙ Percent and direction of slope
--- Stream or Water course

feeds," explained Alva C. Bailey, who, with his brother, Jesse, now operates the farm.

"It was in 1927," the Baileys explain, "that we asked the State university, through our county agent, to help us with a cropping program. We had to

produce more of our own feed. We began farming on an intensive rotation of corn, oats, sweetclover pasture, wheat, and alfalfa (mixed hay), plus the use of lime, phosphates, and animal manures. We have used continually one 25-acre field near the barn for

silage corn, with a lot of manure and rye plowed down.

"Before we adopted that program, we bought tons and tons of feed. The new program of 1927 was a hundred-percent successful in producing the feed we needed. The corn, oats, and wheat furnished the grain and silage we needed for our dairy herd, for our hogs, and poultry flock. It worked fine, but in the last 2 or 3 years of this heavy grain-cropping program we sensed that something was going wrong. We didn't get the yields we thought we should and we noticed something else—more and more of our topsoil seemed to be washing away and accumulating against fences at the bottom of the slopes."

The Bailey brothers recognized it as sheet erosion, winter erosion, especially when their steep corn fields lay bare. Little gullies began to wiggle down the corn rows, fed by water from still smaller lateral fissures in the soil. It was obvious, too, that the soil was not as friable and granular as it was when broken out from sod. It was noticeably harder and tighter and seemed to absorb less water. Some neighbors claimed it was the use of tractors that was causing this.

To the Baileys these were telltale signs. They knew that the cropping program recommended in 1927 was the best known at that time. It had accomplished its purpose of providing the necessary grain and hay and roughage for that big herd of Jerseys. But the Baileys realized that something else had come into the picture. They concluded that it was erosion, and the unseen leaching and washing away of costly lime, phosphate, and manure. During farmers' week in the winter of 1936-37, they again went to the university and their county agent. The Baileys are that sort—they take their problems to the university.

The result was that R. W. Lang, Belmont county agent, asked Conservationist Bazler to replan the Bailey farm for soil conservation. Action was what the Baileys wanted, so together they got busy. Look at the accompanying farm plans and you'll see that the conservationist asked the farm managers to make some fundamental changes in their cropping program. The Baileys were willing to follow the revised plan, if the soil conservationist and the university specialists thought it would accomplish the purpose.

New plans installed contour strip cropping instead of square farming. They created 17 fields in place of the original 20. They called for relocation of fences, but the Baileys have built very little new fence; instead, they have used electric fences to permit temporary pasturage. Study of the original and revised

farm plans will show that fences have been relocated to include most of the steeper land in pasture or woodlands.

Under the old cropping program, corn acreage increased gradually until it was 50 acres. "But our yields have not increased," the Baileys observed.

Under their soil conservation plan they reduced the corn from 50 to 35 acres and eliminated oats entirely. In its place they have grown wheat and winter barley, thus keeping more of the corn strips under cover during fall, winter, and spring. This fall they planted half their corn ground to wheat and half to barley. In spite of their reduced corn acreage, the winter feed supply has been equal to previous years.

The hay acreage was increased nearly 100 percent, and those Jersey cows can use it. Sixty tons of it was made into silage this year. The revised farm plan provides 100 acres of permanent pasture instead of the 50 acres available before, but it is all profitably used. Pasture was one of the problems in the old feeding program. The cropping plan provides for a 5-year rotation, with strip cropping, in fields 3, 4, 8, and 13, allowing one of these fields each year to be in temporary alfalfa pasture to supplement the permanent pasture in summer. This overcomes the weakness in the old cropping plan.

In years past the Bailey farm either produced or purchased annually a small quantity of alfalfa and sweet-clover seed. The new plan called for meadow mixture seedings, and one of the first investments was over \$200 for such seed—this in order to get some hay sods started for strip cropping. "That's a lot of money," Alva Bailey remarked, "but we wanted to do this thing right! We solved our production problem 10 years ago, now we'll do whatever is necessary to conserve the soil. We realize that it will take 4 or 5 years to get the plan in full operation. If this new plan holds the soil as well as the university cropping program produced feed, we'll be more than satisfied."

The rotation field strips are 70 feet wide, except on the sharpest breaks where they are approximately 50 feet. As others who lately have turned to strip cropping have found, the Baileys find the practice is holding the soil and is no more difficult than their old methods. Said one of several Bailey farm employees, who had just finished plowing out some strips: "It was a whole lot easier than I thought it was going to be." He was using a two-bottom plow with an all-purpose tractor and had been dubious about the operation until he tried it.

(Continued on p. 147)

A Jack for Pulling Soil-Sampling Tubes

By C. E. Fisher¹

FOR some time we have needed a simple, lightweight tool for easy removal of soil tubes driven at depths ranging from 4 to 8 feet in obtaining soil samples. A jack of this type has been developed and is described on this page. Its chief advantages are ease and rapidity of manipulation, light weight, simple construction, and low cost. The lightweight jack makes it possible for two men readily to carry the equipment for obtaining soil samples.

The tool has two sets of jaws. One set is made of malleable strap iron. This set encases a second set, the grab jaws, which are machined from cold rolled steel shafting to fit snugly around the tube. The first set of jaws is fastened to the link bars on the lever by means of a bolt provided with an adjustable thumb nut. The grab jaws fit inside the strap-iron jaws and are fastened to them with tap screws.

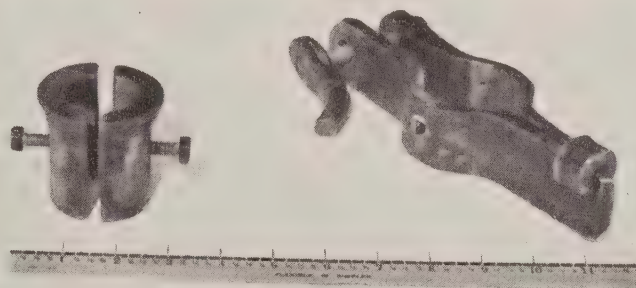
The wooden lever is constructed from seasoned, straight-grained oak, while the fulcrum and base may be made from any durable wood. The base is important because it keeps the jack in the proper position with respect to the tube and also tends to prevent the surface soil from crumbling into the sampling hole.

In sampling, the soil tube is placed through the hole in the base of the jack and driven down into the soil. The slanting fulcrum of the jack keeps the jaws clear of the tube during this operation. In removing the tube from the soil the jaws are clamped around the tube and held in position by means of a small drop flange on one of the strap-iron jaws. A downward pull on the lever tightens the grab jaws and lifts the tubes 4 to 6 inches out of the soil. When the operator pulls upward on the lever the jaws release and slide down on the tube. When the process is repeated the tube is quickly and easily removed from the soil. The jaws are released from the soil tube by raising the strap-iron jaws equipped with the drop flange.

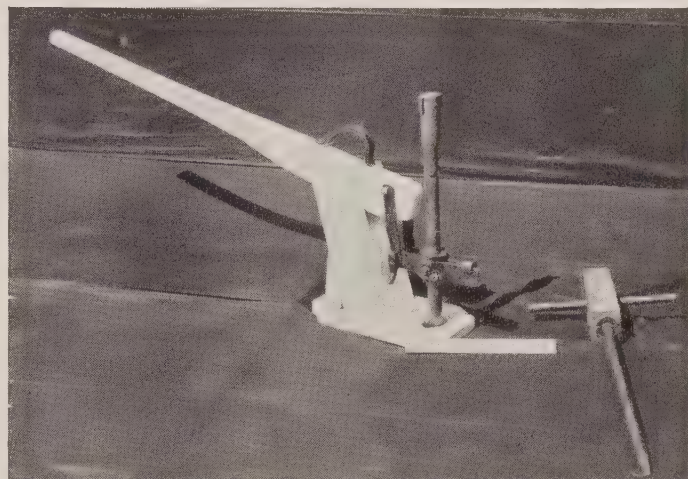
The grab jaws, when properly fitted, will not dent the tube in any way regardless of the weight applied on the lever. If the grab jaws should show a tendency to slip on the tube, the adjustable thumb nut may be manipulated to make the jaws fit snugly. If one is working with highly polished tubes, fine soil dust may be rubbed on the tube or jaws to prevent slipping.

¹ Assistant soil conservationist, Texas Agricultural Experiment Station, in cooperation with the Soil Conservation Service, Spur, Tex.

This jack has been in operation for the past 2 years at the Texas Agricultural Experiment Station at Spur, and has been put to severe tests. It was found that little effort was required to pull tubes driven to a depth of 12 feet in both wet and dry clay soils. With two men operating, the jack has an estimated lifting power of 2,000 pounds. The weight of the jack is 12 pounds and the cost about \$5.



Grab Jaws and Strap-iron Jaws.



Jack in Position for Pulling Soil-sampling Tube. Driving Hammer on the Right.

(Continued from p. 146)

It should be said that soil on this farm is typical of Muskingum silt loam and loam phases. It erodes readily on the slopes that frequently run up to 20 percent. And it should be remembered that this farm, set up as a demonstration to neighboring farmers for conserving soil, is above the average of the community. Far from level, the land is not so steep and rolling as most of the surrounding farms. It is an ideal demonstration farm in several respects.

Since planning this particular group of 53 southeastern Ohio farms, the Soil Conservation Service has broadened the demonstration program in the Buckeye State. Scattered demonstrations have been set up in cooperation with the Extension Service, the Muskingum Conservancy District, the Farm Security Administration, and 22 State-owned farms.

DR. LOWDERMILK Writes on HOLLAND'S Contest With the SEA

HOLLAND teems with land-use problems; its greatest resource is its people, thus far equal to its problems. A land of 8,250,000 acres inhabited by 8,500,000 people, increasing 100,000 each year, must be well managed and treated to maintain its population. The area devoted to field crops is 2,500,000 acres and to grass 3,250,000 acres. Of the total 203,000 land holdings of over 2.5 acres in area, almost a third, or about 63,000, are less than 12.5 acres. Intensive cultivation is necessary.

Holland, once a part of Caesar's Gaul, is not divided into three but into two parts, namely, land above the high tide level and land below high tide level. The land above high tide level lies principally to the east, and comprises sandy lands and fixed dunes of the post-glacial times. This part was, however, the scene of the first agriculture in Holland in Palaeolithic times, which we shall refer to later on. It is the area to which much government attention is given in reclamation, erosion control, and reforestation. The land below high tide level has special interest for us: It comprises about 46 percent of the country; it is the more fertile and productive part of the country; it makes Holland distinctive. For more than a thousand years the Dutch have carried on a contest with the sea for the occupation of the fertile alluvium spread out over the shallow sea bottom by the Rhine and Meuse Rivers of Germany and France. The Dutch have long been schooled in the handling of water and earth. They make water harmless by keeping it on the level by dykes and locks, and they early called the wind to their assistance by the development of the "Dutch windmill," a masterpiece in engineering with materials available to them. Inspection of a windmill, which has been in use for more than 200 years, and still in splendid shape, doing its work of lifting more than 25 cubic feet per second—8 feet when called upon—arouses a high respect for the mechanical ingenuity, as well as cooperative effort, of these people. The dyke associations are older than the Nation of Holland, and some of their regulations have precedence over laws of parliament, for fishing and agriculture were the first occupations of the people.

NOTE.—This article is drawn from a letter recently received by the Chief from W. C. Lowdermilk, who is making a study of erosion conditions in Europe.—*The Editor.*

In modern times the economic structure of the country has changed from its early character; it is a complex industry. Agriculture, commerce, and transport, all play a complex and interrelated role in the country's affairs. While industry and shipping have developed from early times, agriculture still occupies a place of first importance in providing food supplies, raw materials for manufactured food stuffs, for supplying a means of livelihood for a population which industry, commerce, and shipping cannot employ. Between 300,000 to 500,000 employables are unemployed despite the large efforts in construction of reclamation projects, roads, and other works. Such is the impelling justification for the great Zuider Zee reclamation project.

In a land where there is scarcely 1 acre for each inhabitant it is interesting to have a census of farm animals. In 1936 there were 2,570,000 cattle, of which 1,455,000 were milching cows, 1,680,000 hogs, 295,000 horses, 655,000 sheep, 27,800,000 chickens, and 775,000 ducks. Along with this food-producing life are the fisheries which extend from the canals and local waters to the North Sea, and into the Atlantic Ocean as well. Fisheries supplied the market with 233,000 long tons of fish and sea foods.

When the history and the needs of this people are considered, one understands better the Zuider Zee project. It must be noted that the "Zuider Zee" is the name for the former body of sea water. The name is changed to Yssel Meer as the name for the new body of fresh water. The sea sluices discharge daily at low tide and close at high tide. Thus the original sea water is progressively diluted by the fresh waters of the Rhine discharge and of local streams. Within a few years the surface waters will be fresh, and suitable for much needed water supplies to surrounding municipalities.

Mr. van Panhuys of the Ministry of Works and Agriculture was designated to conduct us over the Zuider Zee project. This vast undertaking on the part of the Dutch people is one of the outstanding achievements of mankind throughout the ages. It is like unto the terracing of the mountain sides of Peru by the Pre-Incas. It excels the accomplishments of the ancient Peruvians, however, because of the dependence of success upon thorough planning, coordi-

nation and utilization of great machines to accomplish a definite task within a certain time. The great dyke against the North Sea had to be completed and entirely closed before the next step could be taken. The Zuider Zee project will, when completed, put into cultivation 550,000 acres of fertile land at a total cost of approximately \$1,000 an acre.

The question arises: Does this sort of thing pay—is it economical? Frankly I do not believe it is economical in the usual sense of the word. It has thus far been impossible to get a figure of the commitments of the Government to the project. One is put off by the statement that the funds used for this project were included within the general appropriation. The appropriations are not itemized for this project. It is a part of the general expense of the country as a whole.

Holland is hard pressed for sufficient land for her people. Thus the project can be justified on the basis of national effort for the maintenance of population, rather than the economics of cost and returns, acre by acre. The outstanding lesson to us is: If a nation will go to such lengths to push back the sea to make new land for its people, surely our people should take thought and spend what is necessary to conserve such land as we have.

The Zuider Zee project is not complete; only the Wieringermeer Polder has been dewatered and put into cultivation. This polder has an area of 20,000 hectares, or 50,000 acres, and represents the experimental polder, as a guide to the work in dewatering, and preparation for cultivation of the other three polders with an aggregate area of 200,000 hectares. Dykes are now being constructed about the Northeast Polder; the dyking was completed 10 years ago. The Wieringermeer Dyke, enclosing the first polder, was completed 7 years ago; the water was pumped out by two enormous pumping plants in about 6½ months, by August 21, 1930. The principal drainage canals were dug under water so as to provide for rapid drainage of the area as well as for transportation in the early days of the new land. After the land had been exposed, lateral drains were dug 2 feet deep, 35 to 60 feet apart, varying with the permeability of the soil. This work was done both by machinery and by hand labor. In a comparatively short time the area was drained of all surface waters, and the drainage of the water-logged soils was under way.

It is interesting to note that as soon as this newborn land was exposed to the wind and rain considerable erosion, both wind and water, occurred. The sandy portion of the polder near the sea inlet suffered from wind erosion, and the heavier clay soils of very gentle

slopes suffered from water erosion under the fairly light rains of Holland. Water erosion was due principally to the long unbroken slopes of the former sea floor, and the low intake rate or infiltration capacity of the newborn land. Breaking up of the slopes into narrow sections by the digging of the lateral drains reduced this type of erosion to negligible amounts during this period.

The plans for the utilization of this 20,000-hectare area was well worked out before the dewatering, on the basis of a soils map, compiled from some 34,000 soil samples taken under water. The samples were collected by special equipment to depths of 1.5 meters, or nearly 5 feet. On the basis of mechanical and chemical analyses of these samples, a soils map was prepared before the water had been pumped away. It was thus possible to plan the pattern of drainage canals and ditches, and type of farming, before the land was exposed.

It is remarkable that the salt was leached out of the sandy soils within one winter's rainy season, and out of the clay soils in from two to three rainy seasons, sufficiently to support the growth of plants.

The soil material of the sea bottom had been saturated with salt water for centuries; all air had been excluded. Analyses of soil water gave the same salt content as those of the sea water. One of the principal problems was to leach out the salt.

Rainwater had to be depended upon for this essential operation. The average rainfall on the area is about 700 mm, or 28 inches, of which 400 mm, or 16 inches, is evaporated, leaving about 12 inches to do the leaching. In the first stages much of this 12 inches flowed overland into drainage ditches causing erosion, but as the soil was voided of water, and vegetation covered the surface, percolation through the soil into the drainage ditches became effective. The rate of percolation of course depended upon the textural character of the material—slow in clays, and rapid in sands. Likewise, the clays contained up to four times the total amount of salt contained by the sand, requiring a greater total quantity of fresh water percolation for the removal of the salt.

Although rainfall is well distributed throughout the year the high evaporation rates of summer reduced effective percolation so much that the winter seasons (October to March) had to be depended on for the effective leaching out of the salts. When the surface layer of "soil" was leached to a depth of 8 inches, the chances for successful cropping were good even though the lower layers were still salty. The dry winter of 1931-32 retarded the rate of leaching. From the ex-

perience in the Wieringermeer Polder it can be said that, under normal winter rainfall of an annual 28 inches, clay lands will be desalted enough in 2 to 3 years to allow the sowing of grains with good chances of success; for sandy lands the period is much shorter, 1 or 2 years.

The structure of the soil material was studied in detail on the exposure of the secondary drains. A map was drawn up from these profile observations with remarkable detail. Old marsh subsoils, buried for many centuries, were of special interest. Geologically, the reclaimed polder, now 13 to 16 feet below sea level, was some 4,000 years ago at sea level. The land has been sinking at the rate of 1 mm per year. Buried marsh subsoils filled with decomposed roots and root channels of *Fragmitis communis* were examined in the field. Accumulations of yellow FeS occur in root channels. The pH of this material is 2 to 3. Heavy liming as well as aeration is required to make it productive of crop growth.

An interesting succession of volunteer vegetation came in on the area, of which salt bush and wild aster were the dominant species. Grains were first sown with partial success. But within 3 years the land is sufficiently supplied with lime, phosphates, potassium, and nitrogen, through fertilizers and green manure crops, to turn it over to the farmers for cultivation. The practice is to turn over to the farmers the land covered with a legume, either alfalfa or clover, or both.

The Government retains the ownership of the land and only leases it out for a period of 6 years to a selected applicant. The farming operations are entirely under Government control, until the farm is leased to the farmer. He is then given detailed advice in the management and cropping of this newborn land. He is not compelled to follow the advice, but because of the unusual problems confronting them, the farmers are quite ready to accept the advice of the technical experts. The successful handling of the farm will determine renewal of the lease. This past year there were 51 farms available, and for these more than 1,030 applications were received. Thus a very careful selection can be made.

Mr. de Jong, who is the land manager for the Wieringermeer Polder, was very courteous and willing to give us the details of their methods of handling land applicants and the farms. He holds a position not unlike that of Saint Peter, who determines who should be admitted to this new heaven on earth. The Dutch are planning to avoid on this newborn land the sins of the agriculture of the past.

We were interested in the contract with the farmers

and secured copies of both the application and the contract. The Consul General of Amsterdam, at the request of the Legation Office, was good enough to translate these for us.

The Government builds the dykes, prepares the land, cropping it through the nursing stage, builds the houses and the barns, and is responsible for the entire drainage system. The Government furnishes technical advice for the farming of the new land; it does not require that the farmer follow the advice. He is put upon his own responsibility to run his farm under the broad terms of his lease contract with the Government.

The applicant, to be successful, must be of good character, and of good family; must have sufficient capital to equip the farm with machinery, to set up housekeeping, and to carry him through a period of possible crop failure. The source of his finances may not be a bank but relatives. The reason for this appears to be that relatives will be more lenient during hard times than a bank. It is not desired that banks gain a foothold in the control of the farmers' finances in this area.

Farms are laid out in different sizes—smaller in the sandy lands and larger in the clay lands. The sandy lands are suited best to all grass or dairy farms of one-family size with no hired labor required. The clay-land farms are suited to growing of grains, and are expected to require hired farm labor. Mixed farms are of an intermediate size. The areas vary from 50 to 65 acres for small dairy farms to 120 to 175 acres for the grain farms, where the farmer becomes essentially a manager.

Suffice it to say, that the principal crops are wheat, barley, rye, pasture, sugar beets, potatoes, cabbage, and other vegetables. We marvel at this magnificent achievement. It goes to show that newborn lands of suitable textural character and composition can be made to produce heavy crops regardless of the profile development. There are some far-reaching implications in this fact.

This vast undertaking, however, has been under consideration for a long time. The first serious thought of such a project was presented some 200 years ago. It was seriously considered nearly a century ago, and the plans which were finally followed were prepared by Lely some 30 years before they were actually put into effect by approval and an appropriation of the Dutch Parliament (1918). A period of a generation was given over to discussion and planning, before the project was finally approved and put into effect.

We had a number of conferences with some of the outstanding authorities in Holland, but unfortunately

there was no time to visit and consult with all of those whose names we had listed in our itinerary. Especially was I interested in our conference with Dr. van Iterson, president of the National Research Council, and director of the Organization of Applied Sciences. We had much in common in discussing the problems of how to make research responsive to practical farming and action programs in agriculture, and to make such practice and action programs responsive to the findings in research. Dr. van Iterson informed us of a law passed in 1930 to bring about such an objective, but thus far the stipulations of the law had not been put into practice. He is responsible for finding a way to apply the intent of the law, and confided in us that it is a difficult matter.

There is a tendency in Holland to make a sharp distinction between science and practice in agriculture. Laboratory scientists and the farmers are separated by a wide gap. Field men have not yet been given enough standing. Thus far, the laboratory scientists dominate agricultural science. I found some who deplore this domination of the laboratory analysts in agriculture in Holland. They speak very highly of our method in the United States of giving soil surveyors standing and of accepting their conclusions drawn from their field observations—and where laboratory analyses are used to supplement the interpretation of the field observations.

There was not time to visit the Koloniaal Institute in Amsterdam, as I had hoped to do. In fact, there were a number of things which we were unable to do on this part of our trip, which I hope may be done on the return, if at all possible.

HYDRAULIC LABORATORY: We spent an interesting day at Delft, visiting Professor Muysken, of the University of Delft, who conducted us over the Hydraulic Laboratory. We shall have more to say of this in a separate memorandum to our research group. We found this famous laboratory engaged in model experiments to find solutions of dealing with bed-load sands. A most interesting problem had been worked out in models. The problem was to keep a river channel clean where it crossed a canal; the river was one of the branches of the Rhine, and the canal one of the large canals so common throughout Holland. The solution consisted in constricting the river channel as it entered the canal, and as it left the canal; circular bays with a diameter twice the width of the canal were built on each side of the river channel so that the constriction wing walls coincided with the circumference of the bays. As the river current passed through the waters of the canal a portion of the current would be split off on the far restriction wing

wall, and follow around the circumference of the bay and in its circular course impinge upon the river current as it passed through the canal waters. The eddy waters of the bays served as two water roller bearings on each side of the river channel. They served to restrict the width of the river current by the eddying water. The velocity of the river current was maintained and bed-load material was carried through the canal. This was one of the neatest solutions to a problem of this character that I have ever seen.

The people of Holland were very concerned a few years ago with the rate at which the three channels of the Rhine were filling up with sand washed down from the higher reaches of the stream. After a time the bed of the channel had been raised more than 4 meters; the dykes were becoming dangerously high. About this time demands for building sand increased. The sands of the Rhine were found suitable. Dredging of the sands began and the bottom of the river was gradually lowered 4 meters. And now the demand for sand is greater than the bed-load inflow from the upper reaches. Accordingly, a law has been enacted which fixed the extraction of sand from the river to an amount equal to the annual inflow.

Wageningen, the site of the agricultural college, is a most interesting place. We found evidences of serious wind erosion over an extensive area, covering, we were told, as much as 60,000 hectares, or more than 120,000 acres. These are the sandy lands above high tide level. It appears that man entered this area of eastern Holland soon after the recession of the ice sheet of the last glacial period, when the land was covered with tundra. Evidences were found to show that he depended on the reindeer as a stock animal. The forest cover invaded the area during man's occupation, so that civilization and forests have developed together in this area. We were shown by Dr. Edelman and Dr. Oosting, in pits dug especially for us in the field, evidences of formerly cultivated soils overwhelmed by sand, later covered with vegetation, cleared and cultivated, and again abandoned and overwhelmed by sand and recovered by vegetation. The fields of early man in this period were small. Apparently at some time or other the entire area had been worked over more than once.

It was the custom in early times to border fields with earthen walls on which oaks were planted to form oak hedges. These evidences open up a most fascinating chapter in land use, and we shall follow the work of the soils men and geologists at Wageningen with special interest. Practically nothing of their work has thus far been published, but will create great special interest.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



BEHOLD OUR LAND. By Russell Lord. Boston, October 1938.

This is a background book, for people capable of thinking. It should be immediately commended to the schools so that teachers may read it and in one way or another use it in building up courses including sound conservation material. Mr. Lord's great story of "soil, air, water, and protoplasm—plant, animal, human—all part of the same going concern" is more than a book about the land. It gives us a new philosophy of earth use, of depressions and leadership and the "groping humility" of masses seeking comfort, of despoliation of the land and the "free spirit." Almost, it gives us the reason for the human race on earth, using lands and waters and minerals and animal and plant life—to say nothing of the air we breathe; some reason for the everlasting persistence of human genius and effort. Because of its wealth of authentic information, *Behold Our Land* will make remarkably fine supplementary reading for upper-grade and high schools, while teachers in lower grades will find what they have been looking for in the way of soil and water conservation material suitable for adaptation to nature study, geography, and history classroom studies and activities.

The best thing about Mr. Lord's book is its authenticity. Next best is its way of telling, for the style is vigorous and purposeful—the style of a writer who knows what he is writing about, who makes no guesses and whose vision pierces the curtains of *laissez-faire* and uncertainty. When Russell Lord reminds us that "our last farmland frontiers in Montana and elsewhere went to smash in the post-war collapse that hit far-western agriculture along with drought in the early 1920's" and that the depression which started in 1929 "was the first major depression we had to stand and face without new country 'back of yonder' to surge upon and possess," we are brought up with a jerk because we know that the statement is utterly true. We know that our surging and possessing days are over and that the immediate future must bring conservation, reconstruction and rehabilitation or else—What else but decadence? The United States, *decadent*. It is unthinkable. And because it is unthinkable, this book is strongly recommended for adaptation in the schools.

For good reason, *Behold Our Land* was chosen by the Scientific Book Club as the October scientific book of the month. As many of us know, it was at the request of the Chief of the Soil Conservation Service, Dr. H. H. Bennett, that Russell Lord began, 3 years ago, the gathering together and the sifting and sorting of accurate data and authentic information for the making of a publication which would tell the whole story and the true story about soil wastage in our country, its history, causes and effects, and the conservation practices now being pushed to repair the damage before it is too late. Much of the material is Soil Conservation Service material, gleaned from many projects. The photographic sections of the book show some of our finest pictures which tell their own story of soil healing.

As for the story itself—it reads like a novel, tells many a tale of the people as they surge back and forth across the land—it is absorbing and packed with pertinent information. There is a chapter on "elder lands" wherein we find sketches of ancient places and peoples, China, the Holy Land, and Egypt, Mediterranean countries rising to magnificence and falling upon harassed and subdued soil, Old Germany with her groves and tribal deities; and then the lost splendors of the Incas and the Mayas. All great and glorious for a time, but bungling in agriculture; all perished from the earth. This chapter on elder lands is excellent background, swiftly told and vigorous—the story of ancient man as a despoiler of land.

And then the New Land, our land, America, United States soil. Guided by Russell Lord we look at our country, *then* and *now*. We follow the western migrations and read the account of the gathering of "princely fruits" of the soil, of the harvest of wildlife and the death of the trees. Of "wounded grass" and encroaching desert, dust, maddened rivers. It would be depressing indeed were it not for one thing: As we go along we are shown soil- and water-conservation projects and demonstrations, grass laying the dust, young grass, young shrubs, and young trees clothing the

wounded slopes, crops on the contour, gullies healed, havens for birds and animals—the Soil Conservation Service at work with many thousands of farmers who eagerly come to look and go home to do.

In *Behold Our Land* there is a map of our country that you can feel. This book advertises soil healing to the people who are responsible for that map—that country.

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An abstract of Parts I and II of this valuable bibliography appeared in the March 1938 issue of *SOIL CONSERVATION*, page 243. Part III, which has just arrived from England, contains about 3,500 references of forest-protection and related subjects. The material is organized under seven headings: (1) Man. Demarcation, offenses; (2) Animals, including bird and game preservation; (3) Atmospheric influences. Frost, isolation, wind, hail, snow, etc.; (4) Fire; (5) Weeds, including phanerogamous parasites, climbers, etc.; (6) Other agencies: Floods, swamps, shifting sands, avalanches, landslips, etc.; reclamation works, including protection afforestation; drainage; damage by chemical fumes; shelterbelts, shade trees, etc.; (7) Fencing, including hedges.

Section 6 should be consulted for references pertaining to soil erosion and its control.

AGROECOLOGY AS A BASIC SCIENCE OF SOIL CONSERVATION

(Continued from p. 141)

establishment of real typical hardy strains (agrochorotypes) for the region.

In any case the object of agroecology is to find proper methods for description and classification of regional ecological types of our agricultural plants. This classification should be of great value to agriculture; existing old-fashioned taxonomic classifications are altogether unsatisfactory and do not cover the great diversity of cultivated plants. Agroecological classification, moreover, should be based upon taxonomic classification as a starting point. We shall consider some ecological features comprising the ecotype, as modifications (continued modifications), which I indicate thus:

Caulomorphosae.....for stem modifications.
Rhizomorphosae.....for root modifications.
Clonomorphosae.....for branch modifications.
Anthomorphosae.....for flower modifications.
Carpomorphosae.....for fruit modifications.

Only on the basis of close study of these features of chorotypes can we get material for comparative studies of regional types of crop plants. Comparison will show that the chorotypes are *isotypical*, *homotypical*, or *heterotypical* to each other. All regional types—agroecotypes or agrochorotypes—should be described on the basis of ecological *diagnosis*, similar to taxonomic diagnosis, but with more detailed description of all vegetative parts, reproductive characteristics, and yield.

Bulletins On Varied Topics For Supplementary Reading



For **REFERENCE**
Compiled
by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

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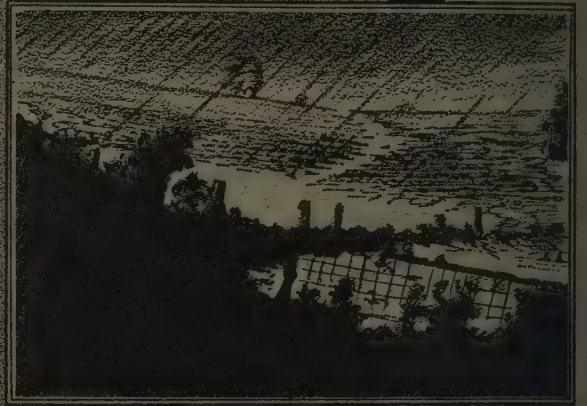
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¹ Issued for use by Soil Conservation Service staff and cooperating officials only.
² From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

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**SOIL
CONSERVATION
ANTICIPATES
INTENSE
RAINS**

**The
Storm**



**Waters
Concentrate**



Scouring Slopes



Run - off



Depositing Silt



Crop Damage

SOIL CONSERVATION

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UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



JANUARY
ENGINEERING ISSUE
1939

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EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

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H. H. BENNETT
Chief, Soil Conservation Service

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

THE job of the engineer in a soil and water conservation program is to apply sound principles and works on agricultural lands. The same fundamentals of hydraulics, mathematics, physics, mechanics, and other sciences are as necessary here as in larger and more intricate structures, but their application requires new thinking and the development of new techniques. There is a woeful lack of relevant and essential agricultural engineering data, the urgent need for which becomes immediately manifest in actual field experience.

Soil conservation engineering structures are none the less vital because they are of small size. Often their very smallness makes them much more complex and difficult to treat. Especially is this true when the economics of the situation is considered. Small works scattered over large areas entail proportionately larger costs for planning and supervision. The balancing of such costs with the usual modest income from the farm is a problem to tax the ability of the most able engineer in devising methods of application, developing techniques, and standardizing practices.

The existing system of land tenure requires the conservation program to be applied on a farm unit basis. The needs of the land for conservation, the cropping practices followed, and the ability of the farmer or rancher to finance the necessary measures, must all be considered by the engineer in advancing his part of the program. Numerous other factors of an inherent nature, such as soil characteristics, slope, climatic features, run-off, and adaptable vegetation, also have a bearing. The engineer who has a good agricultural background is usually best qualified to cope with these problems.

To give proper weight to these factors and apply

corrective measures to each piece of land in accordance with its needs and adaptability, the Soil Conservation Service employs a group of technicians, including agronomists, soil scientists, farm management specialists, foresters, and engineers, whose task it is to examine the problem as a group and together to work out a coordinated program. Thus, the engineer fits his contributions into a pattern of which he is but one of the designers.

There are certain fundamental methods of control on cultivated land which I feel should be set forth

ENGINEERING IN SOIL AND WATER CONSERVATION

By T. B. Chambers¹

here. By an analysis of each method the engineer can more readily determine what he must do to accomplish the desired objectives. These fundamental methods are: (1) The improvement of the textural characteristics of the soil; (2) the use of vegetation to bind the soil in place and, (3) the interception and diversion or storage of surface run-off.

I am of the opinion that these three items constitute the main field in which the engineer should concentrate his efforts and clearly define his responsibilities in the conservation program. The complete and intensive application of these fundamental methods, if properly coordinated, should ensure both the maximum control of soil losses caused by wind or water, and the conservation of water in the arid and semiarid regions.

The improvement of the soil's physical condition, especially where long continued abuses have depleted organic matter and mineral nutrients, is of first consid-

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eration. The rate of absorption and the quantity of rainfall storage can be greatly increased by the addition of humus and the action of plant roots, as has been proved on the soil erosion experiment stations. The methods chiefly favored are agronomic; they consist of crop rotations, use of legumes and grasses, fertilization, liming, etc. These practices need not be discussed here, but they are of extreme value to the engineer since by their use more water is stored in the ground. The engineer knows that every drop that can be made to soak into the ground means just that much less surface water with which to contend. In regions where wind erosion is the main problem, increased absorption of moisture helps to produce a protective cover and prevent soil losses.

In addition to the agronomic practices usually applicable, certain mechanical measures may be used. Deep tillage is adaptable to some soils and, by breaking up tight subsurface structures, may appreciably increase the rate of infiltration and storage capacity. Improved tillage practices, either by special machines or by timely operation in relation to season or the soil's moisture content, may be useful. A study of the condition may suggest to the engineer other mechanical practices that are adaptable, but the essential thing to him is that he do all that can be done to provide, by decreased run-off, increased protection to any structural measures.

The use of vegetation to bind the soil in place and retard surface flow is a practical conservation measure generally understood and extensively used by the agronomist and forester in controlling water and wind erosion. Such practices as strip cropping, pasture and range improvement, long rotations to include several years of erosion-resisting crops, reforestation, and retirement of critical areas to close-growing vegetation are adaptable to many conditions and usually are economically feasible and effective. To the engineer these measures are of value in protecting structures by retardation of flow and reduction of silt load.

Engineers find ready use for vegetation in a practical conservation program. Grasses, vines, and shrubs are used to protect cut-and-fill slopes on highways, gully banks, earth dams, and other erodible slopes. Grasses have been successfully used to stabilize the spillway sections of low dams serving small drainage areas, and diversion channels have been made practicable by filter strips of vegetation being placed immediately above them. Probably the most valuable use of vegetation in providing stable structures is as a lining for low-velocity channels. Terrace outlets and natural drainageways have been successfully protected against velocities of 8 to 10 feet per second by well established

Bermuda grass sod, while grasses forming less dense sods have withstood velocities of 5 to 7 feet per second. Vegetation so used becomes a material of construction, and more knowledge is needed as to its value and dependability under unfavorable conditions. The agronomist supplies directions for the adaptation, propagation, and growth of such vegetation, but the engineer has contributed materially in determining the resistance of various grass covers, in improving methods of transplanting sods, and in reshaping and flattening cross sections so as to ensure more successful plant growth.

Severely eroded areas may be incapable of producing, unaided, a protecting cover of vegetation. The engineer may often use structural treatment such as terraces, contour ridges or diversions, to protect such areas while a cover is being established.

The third method—the interception and storage or diversion of surface water—is largely left to the engineer. An important feature of conservation engineering is that in the humid sections of the country the problem is largely one of getting rid of excess precipitation without damage to the soil by washing, while in the arid regions the problem is largely the reverse, that is, to hold on and in the soil as much as possible of the scant precipitation which occurs.

In the humid sections the interception and disposal of excess surface water is the engineer's chief job. Experiment station records indicate that erosion is directly proportional to the intensity and duration of flow. In order to shorten the surface run and prevent the cumulative increase in volume of flow down the slope, terraces or diversion ditches are constructed at intervals to act as primary interceptors. The intercepted water must be carried at nonerosive velocities into protected drainageways for delivery into natural streams or drainage courses. The terrace or diversion system should preferably be constructed on a farm-unit basis, but the initial planning for all run-off disposal measures should be on a watershed basis. Since farm boundary lines and watershed dimensions seldom correspond, it is often necessary to consider and provide for run-off from adjacent farms in the development of run-off disposal plans for individual farms. Farm run-off disposal facilities must be in harmony with the natural drainage requirements of the entire watershed.

In the semiarid regions the engineer is more concerned with storage and utilization of water. Dams for storage or for diversion and spreading systems, which divert concentrated flow to unwatered areas, are of primary consideration for both range and culti-

vated land. Level terraces on cultivated land, to impound run-off and distribute it over the surface for absorption and benefit to subsequent crops, are adaptable to the flatter slopes. Contour furrows and contour tillage provide numerous small depressions for surface storage and are adaptable to nearly all conditions.

In addition, there is often need to establish conservation practices on lands not used for cropping purposes and to build on them structures indirectly related to erosion control. For instance, the practice of controlled grazing on range land requires proper distribution and rotation of cattle over the area. Water is usually scarce in the range country, but water at strategic locations must be supplied to facilitate proper use of the range. The construction of impounding dams and stock tanks or well and spring developments to supply this water becomes a job for the engineer.

Where adequate erosion control cannot be economically provided on watersheds, it may be necessary to resort to desilting basins and silt traps formed by dams or dikes to arrest the flow of silt and protect irrigation or drainage systems from damage or to protect low-lying fertile lands from deposition of infertile material. Or it may be necessary to arrest the headward extension of an overfall-type gully, by dams or other structures, to prevent its encroachment on to highways or other improvements, or to stop its extension through fertile lands. Structures are sometimes required to stabilize the banks of a meandering stream and prevent the washing away of good farm land.

The improper application of irrigation water to steep slopes may be the cause of serious erosion. Adjustment of the methods of applying the water are sometimes necessary and may require a change in the irrigation system to afford either shorter runs over steep slopes or flatter grades in the delivery channels.

A special problem which involves practices already described but requires a somewhat different application is erosion control on highways. The highway location often cuts across the drainage pattern of a watershed and complicates the problem of safe run-off disposal. Considerable surface water may be intercepted by the road ditches, diverted from its natural channel of concentration and discharged at places where adequate protection is difficult to provide. Rearrangement of the highway drainage system, to permit more economical and effective disposal control, is sometimes possible. Gullies which form where side drainage enters over cut banks and at the entrance to culverts require correction by vegetation or structures

This issue of SOIL CONSERVATION was planned too early to include engineering articles on drainage, irrigation, and the development of marginal land. It is expected that later issues of the magazine will contain articles in which a correlation of these practices with soil-conservation objectives will be discussed. The development of more complete soil-conservation and land-use programs has been made possible by recent changes in the Soil Conservation Service.

or the diversion of the water. Erosion along the roadside itself may be causing damage to the road or adjoining lands. The job of protecting the cut-and-fill slopes and the highway ditches is based upon erosion-control principles already outlined.

So far this discussion has touched only on erosion-control and water-conservation methods. To those employed in conservation work it soon becomes apparent that the most effective conservation cannot be secured without proper land use. Slopes may be farmed that are too steep for cultivation and will probably require so many control measures that effective control cannot be secured at an economical cost. Some soils are extremely erodible and cannot be cultivated economically on moderate slopes because of the excessive cost of adequate control measures. A one-crop system may be followed where rotations are needed. Numerous other examples showing the need for proper land use could be cited. No combination of control measures is likely to achieve effective conservation if the land is improperly used.

Added responsibilities recently assigned by the Department of Agriculture broadens to some extent the horizon of the Soil Conservation Service. New activities consist of drainage, water facilities, irrigation, submarginal land acquisition and development, and upstream flood control. They promise to make possible the more complete attainment of the objectives of the Service. They provide additional methods of treatment to achieve proper land use. As the Service will be benefited by these activities, so also will the activities themselves be benefited by increased scope and by integration with other activities to secure a fully coordinated conservation program. For instance, an action program for flood control may embrace application on a watershed basis of most of the conservation features already developed. Soil improvement practices will be required to decrease run-

(Continued on next page)

FARM DRAINAGEWAYS AND OUTLETS¹

By C. L. Hamilton²

PROPER disposal of surface run-off is a major problem in the development of satisfactory farm conservation plans. It is poor planning to expend funds and effort in securing proper land use with contour cultivation, conservation rotations, strip cropping or terraces to conserve the soil on sloping fields, and at the same time to neglect the drainageways which convey concentrated run-off. Ultimate gullyng in neglected drainageways will eventually undermine and destroy the soil conservation measures on the

¹ The term "drainageways" refers primarily to channels of surface drainage in the upper reaches of watersheds or in unit drainage basins. "Outlet" is a more restricted term and refers only to drainageways that are provided to receive and convey the discharge from the ends of terraces.

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CHAMBERS (Continued from preceding page)

off; water flow retardation by vegetation and structures will be necessary; the reestablishment of vegetal cover over critically eroding areas will be essential as a method of silt control; channel improvement and protection, highway erosion control, and gully control over the watershed, all will enter into the picture. In addition to regular erosion-control work, the engineer must be alert to the establishment of upstream detention basins for the slow and orderly passage of peak flows. All the practices used must, of course, be economically feasible from a flood-control standpoint, and benefits accruing must be in excess of the cost.

It will be necessary to evaluate each practice from the standpoint of water flow retardation and silt reduction. A great deal of study will be necessary for such determination. Of particular interest to the engineer will be the routing of peak flows through the tributaries. If upstream detention structures are feasible and practical, there is still the problem of synchronizing the delivery of tributaries so that peak flow at danger points will not be increased. The flood crests in the numerous tributaries may present a complex problem when it is considered that flood damage to a greater or less degree may occur on any of them, and that the same water may participate in more than one overflow in its passage down the watershed. The relative degree of flood damage that may occur in the successively larger tributaries may be a primary consideration in determining the value of upstream storage.

adjacent slopes as well as any benefits derived from them. Supporting field examples can be pointed out everywhere. In the South, where terracing with contour tillage has been widely used for many years, inadequate outlets frequently lead to destruction of the terraces and accelerated gullyng often to such extent that abandonment of entire fields became necessary. In other sections gullyng branching out from unprotected drainageways has destroyed many fields where rotations, contour cultivation, and strip cropping were practiced.

The location of drainageways and outlets also has a marked effect on the ultimate success of the entire farm conservation plan. Recent field observations

The need is acute for data from small areas relative to run-off characteristics from various types of watersheds, and the engineer will be considerably handicapped until more accurate information is available. Devising means to acquire this information becomes one of his more immediate responsibilities.

Land drainage is an engineering activity of long standing, and proper drainage is often necessary for best land use. Fertile bottomlands, too wet for agriculture, can often be placed in profitable cultivation by drainage, thus permitting the retirement of eroding slopes at other places on the watershed. Under certain conditions, the removal of excess ground water by underdrains will prove valuable in increasing the rate and amount of absorption from rainfall.

The Water Facilities Act provides for the storage and use of surface waters and the development and use of subsurface waters in the arid and semiarid sections of the country. The act is of great significance to conservation engineers in these areas since it enables them to consider the watershed as a unit and plan for complete and judicious use of all the water available. The adjustment of supply to needs, where the supply is not sufficient to meet all requirements, must be handled cautiously and in accordance with local laws and water rights, but, in addition, the conservation engineer is concerned with supplying needs that will promote the proper use of land. Coordination with other conservation features is necessary to ensure proper land utilization and protection to the structures involved.

directed attention to farms where complete soil conservation practices had been installed but the entire plan failed to secure wholehearted support of the farmer because of improper drainageway locations. Once established, the relocation of drainageways is usually a costly and discouraging undertaking. Proper drainageway locations are largely dependent upon the natural drainage pattern of the area involved. Drainageways located according to property lines, or for the primary purpose of facilitating conservation measures previously installed, often lead to costly or inconvenient farming systems.

The necessity of establishing satisfactory run-off disposal plans at the outset was not generally recognized during the first attempts to develop complete soil conservation plans for individual farms. The earlier efforts were concentrated on problems of proper land use and determination of practical types of practices to check soil losses on individual fields. It was not until many of the resulting farm plans had been established that the importance of over-all run-off disposal plans were fully realized. The installation of many of the plans proved to be uneconomical, while others required costly readjustments before satisfactory results could be obtained. The most disappointing experience resulted from improper location of many of the initial drainageways; their relocation, to facilitate the establishment of subsequent conservation measures on adjacent fields or farms, required extensive readjustments and expense. Even today some engineers and conservationists do not fully appreciate the necessity of developing adequate run-off disposal plans at the outset.

Planning Run-off Disposal Systems

There are two distinct phases in planning farm run-off disposal systems. The initial or general planning involves the selection of the number, type, and location of required drainageways, and of the installation procedure for each. The secondary or detailed planning involves the determination of capacity, design, and construction or establishment details. The former phase should be included in the development of initial farm conservation plans and the following discussion will be limited to this aspect of run-off disposal planning.

The first step in planning a farm run-off disposal system is to make a physical inspection of the farm and the adjacent areas. The main drainage features such as draws, ridges, and slopes should be noted. Their location and condition are of particular importance. Field and property lines, roads, buildings, fences, etc., while of lesser importance, should also be noted. This

preliminary inspection will reveal the general drainage characteristics of the area and enable a tentative selection of at least the main depressions that should be reserved for permanent drainageways. The number of lateral drainageways required will depend not only on the topographical features but also on the soil conservation practices to be used. For example, where run-off interception is to be provided by the use of terraces or diversion ditches, the retention of some of the minor depressions as permanent drainageways can often be avoided. On areas where no run-off diversion measures are used, all lateral depressions that carry any applicable amount of run-off must be reserved as drainageways. As land use and soil conservation plans are developed for the area, the field boundaries, fence lines, and meadow or pasture areas can often be adjusted so as to make it easier to establish and maintain the selected drainageways.

On areas to be terraced the problem of locating and establishing outlets is inseparably associated with planning the terrace system. The cost of terrace construction, and the ultimate success of the terraces, are dependent upon proper planning of outlets. Conversely, adjustments in the location and in the direction of the flow of terraces will often greatly facilitate outlet control. For example, changing the direction of the terrace grade near the center of a terrace, or running the grade of alternate terraces in opposite directions, will diminish the concentration of run-off and often make it possible to distribute the run-off from a terraced field over native cover on adjoining areas. Where special outlet strips or channels are required, it is often more satisfactory to drain terraces toward the outlet channels from both sides so that each outlet channel will serve a larger area, thus reducing the number required.

It has been found necessary to plan surface drainage systems according to natural drainage units. A drainage unit comprises a natural depression or drainageway together with the land that drains toward it. This means that the initial surface drainage plans for all fields or farms within the drainage unit should be developed concurrently, irrespective of boundary lines. Plans should provide for continuous conveyance of the run-off and economical development of the drainageway from field to field and from farm to farm until a stabilized watercourse is reached. With a properly planned procedure that is in harmony with the natural drainage pattern, drainageways can usually be systematically established, if necessary, by field or farm increments so that each part can be fitted together without difficulty or expense when the final conser-

vation job is completed for the entire drainage unit. In some areas the most effective field application of this plan may even involve the cooperative development and maintenance of certain drainageways by two or more land owners. Recent experience has shown that cooperation between landowners and highway officials, in the subsequent development of dual-purpose drainageways that carry run-off from the highway right-of-way as well as from the adjacent farm land is often advantageous.

various climatic, geographic, soil, and type-of-farming regions.

Due to the diversity of conditions encountered, it is obviously impossible to select a standard method of drainageway protection and attempt to apply it universally. The only satisfactory procedure is to determine in what order the various types of drainageways should be considered and what form of each type is best adapted locally and can be economically established and maintained. From the standpoints of

Classification of drainageways and outlets

Drainageways	Natural		Constructed		
	Vegetated	Unvegetated	Vegetated	Mechanical	Miscellaneous
Draws (unterraced areas)	Grassed ¹ Wooded	Rock	Meadow strip Pasture strip	Drop check Lined ²	Combination. Unlined.
Individual terrace outlet	Grassed slope ¹ Wooded slope	Rock slope	Grassed slope ¹ Wooded slope	Drop check Lined ²	Absorptive. Accumulative.
Collective terrace outlet	Grassed ¹ Wooded	Rock	Meadow or pasture strip. Field or roadside channel.	Drop check Lined ²	Combination Unlined.

¹ Often referred to as meadow or pasture depending upon how the forage is utilized.

² Discharge velocities are usually higher in lined channels and the channels are sometimes referred to as high velocity.

Selection of Type

Natural drainageways that are still protected by native vegetation should always be given first consideration. They should be protected and utilized to the fullest extent possible because it is usually difficult to reestablish or duplicate these original drainageways and, at best, it is frequently a costly procedure. Natural drainageways that have been only partially damaged by overgrazing, or by the development of a few breaks in the original cover, can usually be repaired or restored. The sooner this is done the more successful it will be and the smaller will be the expenditure of labor and materials required.

Since much of the native covering has been plowed up or destroyed and so many drainageways have been severely damaged by gullying, it is necessary to establish many new ones or rebuild old ones. In the reestablishment of these drainageways the results are usually most satisfactory where the natural features are reproduced as nearly as possible. There are some areas, however, where the soil and climatic conditions or artificial conditions introduced with agricultural practices may justify or even necessitate some modification of nature's procedure. It must be recognized that problems of drainageway development are neither equal in importance nor uniform in character in the

economy and practicability, including ease of establishment, the various types of drainageways should be considered in the following order:

1. Vegetated individual outlets (terraced areas only).
2. Meadow or pasture strips.
3. Vegetated channels.
4. Mechanical protection.

In field practice the natural conditions encountered will often prohibit the use of certain types, but the types should usually be given consideration in the order named and no method should be discarded as impractical until thorough investigation has proved it to be so.

Pretreatment of Drainageways and Outlets

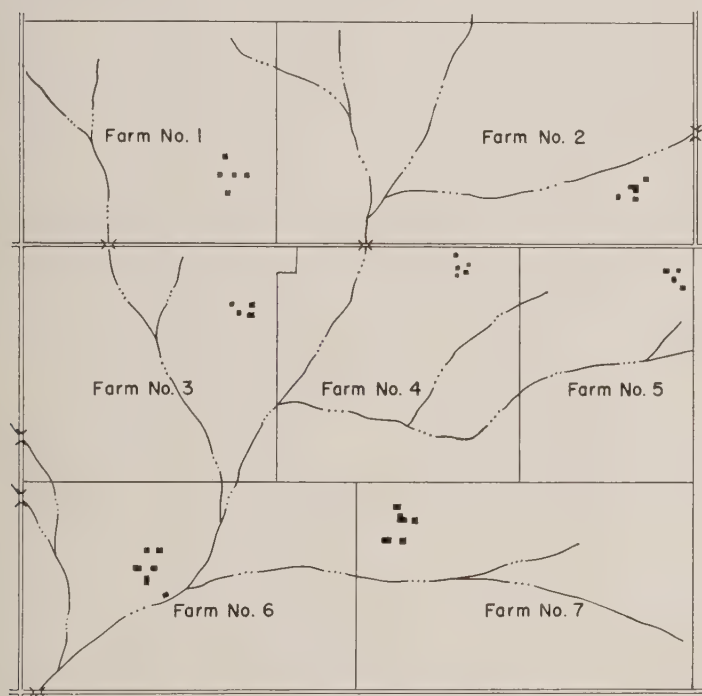
In most areas it has been found not only hazardous but also expensive to attempt to establish grassed drainageways or outlets at the same time that they are being used for the disposal of run-off. This is particularly true on areas where terraces concentrate additional run-off in the drainageways. Newly prepared seedbeds, seeds, fertilizers, and young plants offer little resistance to erosion and are frequently washed out unless special precautions are followed. Solid or strip sodding, when properly anchored, will sometimes carry run-off without harmful results immediately after it has been placed. This, however, is a relatively

costly method of establishing vegetated drainageways, and the expense retards extensive use of vegetal protection. It is sometimes even difficult to anchor newly placed sod in certain channels in such a way that it will not be damaged by heavy run-off. Damage from run-off is more acute in the establishment of vegetation in outlet channels than in wide grassed drainageways because of the higher velocities produced in the smaller channels. There are several possible methods that can be used to save expense, eliminate the run-off hazards, and make the development of seeded drainageways more dependable and practical.

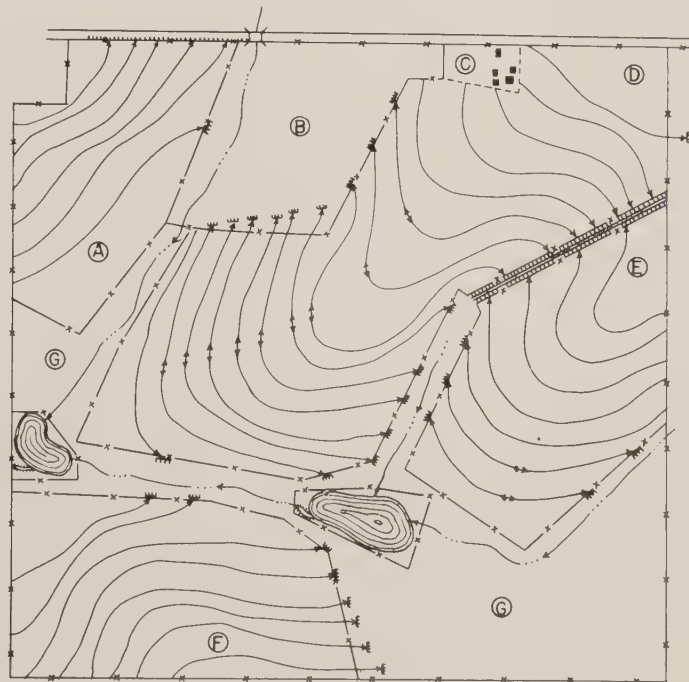
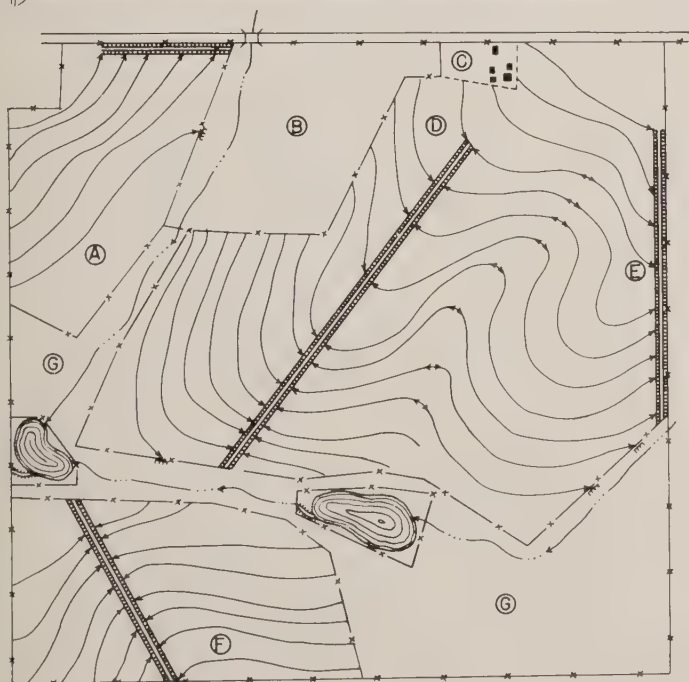
On areas to be terraced one of the most promising plans is the establishment of outlets before the terraces are constructed. A few years ago a general feeling prevailed that the application of this practice would

prove impractical under field conditions. Recent observations and field tests, however, have shown that the establishment of outlets in advance of terracing can, with proper planning, not only be practical but distinctly advantageous in many areas and that it should be given first consideration in the development of any extensive terracing program. As a result of this practice, some Soil Conservation Service project engineers report that C. C. C. camps have been able to accomplish approximately five times as much outlet work as otherwise. They have also been able to establish economical outlet protection where other methods have proved too costly, and the greater accomplishments have resulted in extending the work to many more farms. This experience led to the adoption of the plan as a standard procedure in all field work in Region 2. Establishment of outlets in advance of terracing has also been tried out in Region 4 and is now being extensively advocated in all field work within that region.

The success of this method has been made possible by the complete farm run-off disposal plans which include the number, location, type, and order of drainageway development as a definite part of preliminary farm



Satisfactory run-off disposal on individual farms is dependent upon the development of economical drainageways that are in harmony with the natural drainage pattern of the unit watershed involved. The upper illustration to the left shows why it is usually necessary to consider several fields or farms in the development of initial run-off disposal plans. The lower illustrations show (left) incorrect and (right) correct detailed run-off disposal plans for farm No. 4. Fields A, D, E, and F are terraced and cultivated. B is in woods and G is in pasture. While the incorrect plan may provide safe run-off disposal, its establishment and maintenance will require at least twice as much work and expense as would be necessary with the correct plan.



conservation planning. The location of all terraces to be used, and their direction of drainage, are also specified in the run-off disposal plans. Where this practice is not followed, it is difficult effectively to establish outlets in advance of terrace construction. It is important that the outlets be located and constructed so as to facilitate later terrace construction. Otherwise, they cannot be efficiently used when the final conservation measures are installed and they will represent wasted efforts and expenditures.

For the most effective use of pre-established outlets, the order of terrace construction is largely determined by the order in which established outlets can be made available. Terrace construction is arranged so that the areas for which natural outlets are available, or for which outlet channels require solid sodding or mechanical protection, can be terraced the first year while the vegetation is becoming established in other outlets. Outlets must be established as early as possible in order that the final terrace construction work will not be delayed. The change from the common practice of treating outlets following terracing to the new practice of establishing outlets in advance of terracing will involve a transition period in any terracing program. During this period it may be advisable to establish part of the outlets after terracing so that the terrace construction work may be continued without undue interruption. The length of the transition period will largely depend upon the additional effort directed to outlet construction or the rate at which outlet construction can be temporarily accelerated. The normal rate of outlet construction can be resumed once the outlets are well in advance of terrace construction. The shorter the transition period can be made, the sooner the full benefits of pre-established outlets can be achieved.

Where grassed drainageways are to be established by seeding on untterraced areas or on terraced areas where established outlets are not available, the use of some form of temporary run-off protection is often advantageous. Even with pre-establishment of outlets on areas to be terraced it is often necessary to provide some additional run-off protection during the period in which the grasses are becoming established. In the South where Bermuda grass is commonly used for drainageway protection, the problem seems to be somewhat less acute. Here the Bermuda grass is usually established from rootstalks and stolons by spot, spring, or broadcast sodding. During the initial stages, however, even this procedure is often benefited by some form of temporary run-off protection.

The practice of diverting the run-off, by means of

temporary dikes or ditches, until the vegetation becomes established in the permanent drainageway is often used. The use of a quick-growing annual crop, to stabilize the drainageway before seeding the grasses, is sometimes advisable. Small grains or Sudan grass, domestic ryegrass and similar crops may be seeded in the spring to hold the soil effectively and produce a residue in which to seed the grasses the following fall. Nurse crops may also be seeded with the grasses to afford quick protection, but care must be exercised not to seed too lavishly. Where practical, such run-off retention measures as contour ridging, furrowing, listing, and subsoiling on the contributing watershed, may sufficiently reduce the run-off temporarily to assure satisfactory establishment of drainageway vegetation. On some areas where pre-established outlets were not available, it has been found that subsoiling only the terrace channels and outlets, to a depth of about 18 inches, reduced the run-off sufficiently during the following year to permit the establishment of satisfactory vegetal protection in the outlets.

Providing new grass seedings with some form of surface protection has also facilitated the establishment of drainageway vegetation in some sections. Surface mulching not only protects newly prepared seedbeds, seed, and small plants from run-off and hard rains, but it conserves moisture and produces a surface condition that encourages the germination and growth of small grass seeds. The mulch can be produced by properly anchoring a thin but continuous layer of straw, corn fodder, old hay, or fine brush over the entire seeded area. Loosely woven burlap, tightly drawn and staked to hold it in place, provides good surface protection. While this treatment is more expensive, it may frequently be used advantageously on small areas or at vulnerable points in larger areas. Regardless of which method of run-off protection is used, it is essential that adequate seedbed tilth and fertilization be provided, and that suitable seeding rates and mixtures be used for satisfactory results. Even with run-off protection, it cannot be expected that grasses and legumes will thrive well where topsoil and necessary fertility are lacking.

Since the organization of the Soil Conservation Service, cooperative agreements have been signed for 64,711 farms or ranches, comprising 32,668,979 acres for complete soil- and water-conservation practices. On this acreage 87,626 miles of terraces protecting 1,268,544 acres have been constructed, and 3,418,387 soil-conservation dams have been installed.

GRAPHIC SOLUTION OF CHANNEL DIMENSIONS BY THE MANNING FORMULA

By H. G Jepson¹

THE determination of flow of water in open channels presents a rather complicated problem because of the variety in shapes and sizes of cross sections, the great variation in roughness of channel surfaces, and the apparent discrepancies in experimental data. Many formulas, some of them based on rather meager experimental information, have been developed. Of these the Manning formula is being used extensively by agricultural engineers to compute flow of water in open channels. This formula lends itself readily to solution of diagrams or tables and is more simple of form for analytic solution than most other formulas that have been used. It also appears to be quite accurate within the range of ordinary computations encountered. It is for these reasons that it has been selected for solution of channel problems.

The Manning formula as usually written is:

$$V = \frac{1.486}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

But for solving various types of problems it is more convenient to express it in terms of the discharge equation:

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

where Q = discharge capacity of channel in cubic feet per second,

n = coefficient of roughness for various channel conditions,

A = cross-sectional area of flow in square feet (sometimes expressed in terms of b and d where b equals bottom width of channel and d equals water depth),

R = hydraulic radius of the channel in feet or the cross-sectional area divided by the wetted perimeter,

S = slope, or fall per foot

and V = mean velocity of water in feet per second.

When it is considered that small changes in the channel cross section, in the slope, or in the roughness coefficient may materially change the discharge capacity of that channel, it is readily apparent that a graphical solution of problems would be highly desirable. By ordinary mathematical solution it is

necessary previously to select approximate channel dimensions and then substitute them in the formula to determine whether the assumptions meet the conditions of the problem. A good graph usually enables direct selection of the proper dimensions without resorting to tedious cut-and-try methods and, in addition, gives a much better picture of the practical limitations of the various factors entering into the design. Graphs also enable the selection of a greater number of conditions and combinations than is possible by the use of tables or is ordinarily attempted analytically.

A very compact and relatively simple chart for solution of outlet channel dimensions has recently been developed by V. W. Thalmann, associate agricultural engineer, Soil Conservation Service. The chart is reproduced on page 163. It is to be used only for trapezoidal cross sections having 4:1 side slopes and is best adapted to the design of vegetated outlet channels. Similar charts can, of course, be made for any side slopes desired. The chart enables ready determination of channel dimensions within the range of values ordinarily encountered. The various factors graphically obtainable are V , n , R , S , A , b , d , and $\frac{b}{d}$ ratios including the most economical cross section if desired. It should be noted that the velocity values V are based on a value n of 0.0372 which represents a fairly average figure for accepted values of n for grassed channels in reasonable condition.

If it is desired to apply other values of n a different method of reading velocities is required. A sample problem involving two different values of n is being included in order to facilitate use of the chart. In one case n will be the base value of 0.0372 and in the other will be 0.035. The dotted key solution on the chart is based on the value n of 0.035 in order to illustrate the method of reading velocities when other than the base value 0.0372 is used.

Sample Problem

Given: A terrace outlet channel is to be constructed down a 7-percent slope and treated with vegetation capable of withstanding a maximum velocity of $5\frac{1}{2}$ feet per second. The expected maximum run-off flow to be provided for is 44 cubic feet per second.

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Find: Using 4:1 side slopes and a trapezoidal cross section, what bottom width of channel is required and what will be the depth of flow at capacity discharge?

Solution 1 (When $n=0.035$): (See dotted lines in key solution on chart.) With an n value other than 0.0372 the velocity values cannot be read direct. It has been found, however, that certain relationships exist whereby velocity values may be laid off along the slope lines S when the slope is expressed in percent. Thus, for any values of n other than 0.0372, velocity must be read along the slope scale.

Continuing with the problem, follow the velocity ($5\frac{1}{2}$) along the $S=5\frac{1}{2}$ line to its intersection with $n=0.035$. From this intersection point descend vertically to the intersection with $S=7$. From here read horizontally to the intersection with the required A which is $\frac{Q}{V}=\frac{44}{5.5}$ or 8 square feet. This point falls at approximately 0.36 for d and 20.2 for b . A channel with a bottom width of 20.5 feet and a depth of 5 inches should be used for the conditions given. In field practice additional depth is usually provided to give the necessary factor of safety.

Solution 2 (When $n=0.0372$): (Since the base value of 0.0372 is assumed for n , the velocity values given on the chart may be read direct and the other n values ignored.) Therefore, follow the vertical line $V=5\frac{1}{2}$ to its intersection with the required S line (7). From this point, read horizontally to the intersection with the required A value which is 8 square feet. This intersection point is found to fall at about 18.2 on the b scale and about 0.40 on the d scale. Thus, a trapezoidal channel with a bottom width of 18.5 feet and a depth of about 5 or 6 inches should be used for the conditions given. It will be noted that the value of R can also be obtained during the operation if it is desired to get a reading of the hydraulic radius.

It is evident that such a chart is a great time-saver over laborious substitutions in a formula, and is sufficiently accurate for the design of vegetated outlets where dimensions ordinarily need not be computed to an accuracy of more than a few inches. The fact that individual charts can be used only for channels with side slopes equal to those on which a chart is based, does not materially affect their usefulness because usually certain side slopes are decided upon in a given locality for which charts can then be compiled.

As has been previously pointed out, the Thalman chart is best suited for design of vegetated outlet channels. Where it becomes necessary to resort to masonry or concrete lining for outlet channels, additional factors should be considered in design. For

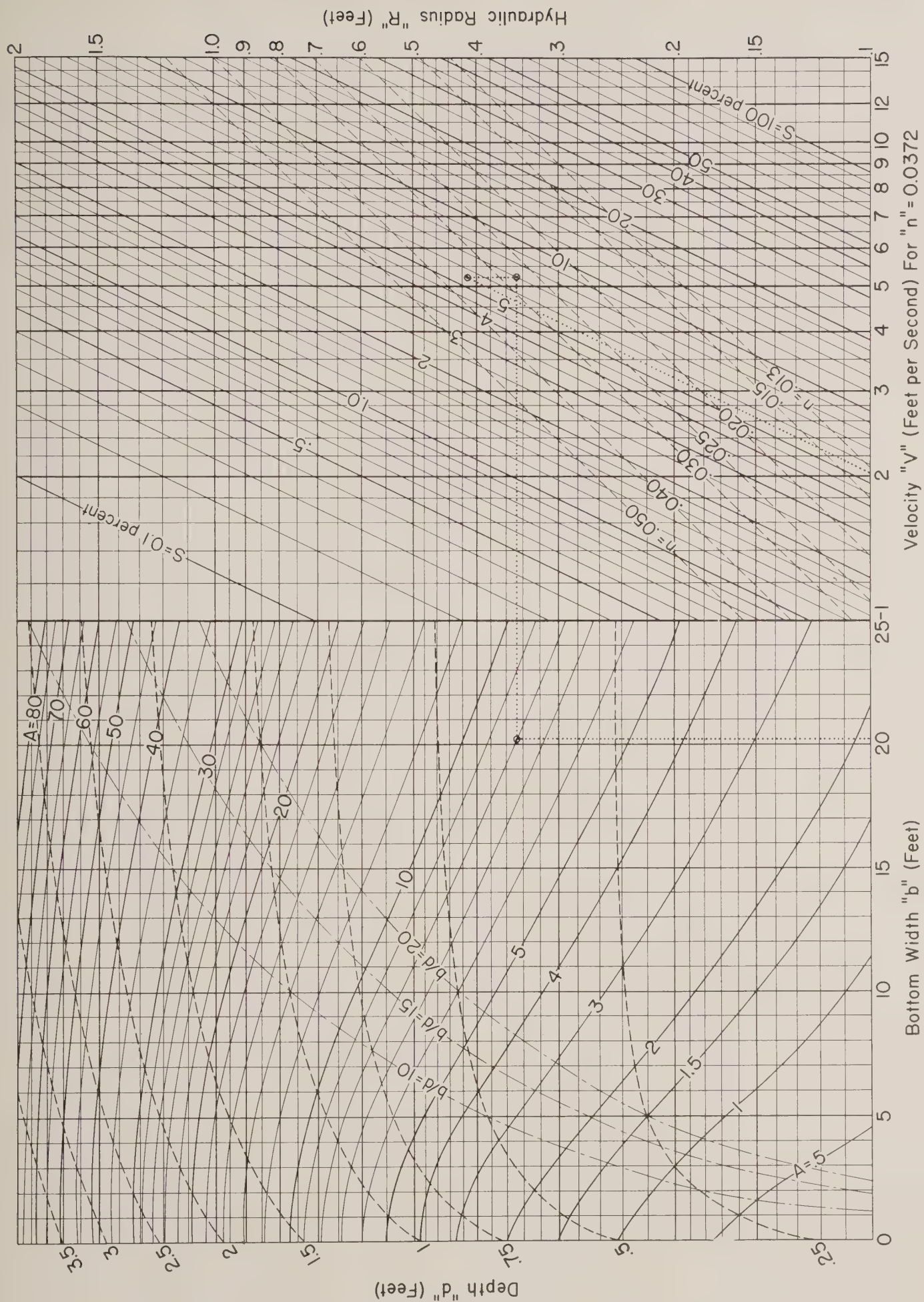
example, in vegetated outlets relatively wide, shallow cross sections are used in order to increase surface contact with water and thus keep velocities low. Where masonry or concrete linings are used, more economical cross sections should be provided. It is evident that if an open channel has a fixed cross-sectional area and slope the maximum discharge will result when the area is so shaped and proportioned that the surface contact between water and channel lining is kept to the minimum. Under such a condition frictional resistance will be a minimum and maximum velocity will occur.

It is a well-known principle that of all geometric figures the circle encloses the greatest area per unit of perimeter. Similarly, then, for open channels the half-circle cross section would present the least amount of surfacing. There are, however, other factors to consider, such as ease of construction which frequently makes the half circle unsatisfactory for general field use. From the standpoint of practical construction, the trapezoidal and rectangular sections are generally the most popular for open channel use. Of these two, the trapezoid, when constructed with the sides and bottom of equal length (half hexagon), more nearly approaches the shape of a half circle and thus should receive consideration where it is necessary to construct a high-velocity channel that must be lined with relatively expensive materials.

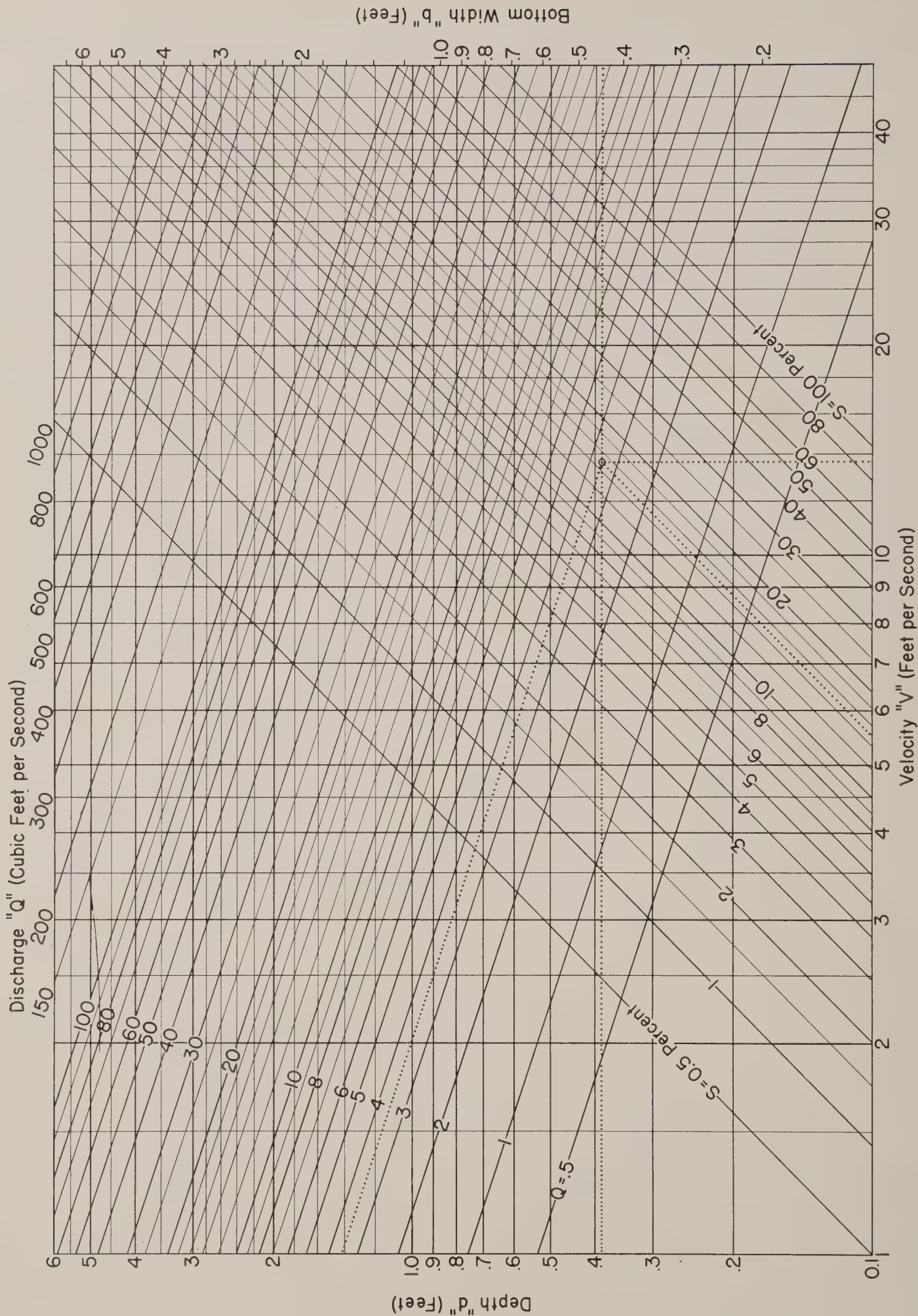
A chart [Graphic Solution of Concrete Channel Dimensions (Most Economical Trapezoidal Cross Section)] has been prepared to provide a diagrammatic solution for the hydraulic elements of a trapezoidal channel having the most effective cross section. This chart is shown on page 164. The chart is based on the Manning formula, and the various terms used have the same meaning as previously described for the Thalman chart. A value n of 0.014 was used, as this is commonly recommended for concrete-lined channels in good condition. In case other lining is used, a different n would be necessary. For example, a good cement-rubble surface would require an n of about 0.020.

The chart for concrete-lined channels can be used in the design of channels lined with cement-rubble if the design values of Q are first divided by the factor $\frac{0.014}{0.020}=0.70$. In other words, to discharge an equal quantity of water within a given period of time a somewhat larger cross section is required for rubble masonry than for concrete. This results because of differences in frictional resistance. A sample problem is being included to indicate usage of the chart. Solution 1 is for a concrete-lined channel, and solution 2 is for rubble-masonry lining.

(Continued on p. 165)



GRAPHIC SOLUTION OF OUTLET CHANNEL DIMENSIONS. (Trapezoidal Cross Section with 4:1 Side Slopes)



GRAPHIC SOLUTION OF CONCRETE CHANNEL DIMENSIONS. (Most Economical Trapezoidal Cross Section)

By Manning Formula $V = \frac{1.486}{n} R^{2/3} S^{1/2}$ For $n = 0.014$

Sample Problem

Given: A high-velocity channel of trapezoidal section is to be constructed down a 15-percent slope. The expected maximum run-off flow is 3.5 cubic feet per second.

Find: What bottom width of channel is required and what will be the depth of flow at capacity discharge? Also, determine the velocity at peak discharge.

Solution 1: (See dotted lines in key solution on chart.) Follow the $Q=3.5$ line to its intersection with $S=15$. From here read horizontally to the left for d values, horizontally to the right for b , and vertically down for V . It will be found that d is approximately 0.38 feet, b about 0.44 feet, and V about 13.6 feet per second. Thus, a trapezoidal channel about 5 inches deep and $5\frac{1}{2}$ inches wide at the bottom should be able to carry the peak discharge. Since the section is a half-hexagon the channel sides should be of the same length as the bottom. This will give side slopes of 0.577 to 1, or approximately 0.6 to 1.

Solution 2: (Rubble-masonry lining) Divide $Q=3.5$ by 0.70 which is 5.0. Follow the $Q=5$ line to its intersection with $S=15$. From here the values of d and b can be read as was done in solution 1. It will be found that a trapezoidal channel about $5\frac{1}{2}$ inches deep and about $6\frac{1}{4}$ inches wide at the bottom is required to carry 3.5 cubic feet per second discharge when rubble-masonry is used for lining. The channel sides will, of course, have the same slopes as in solution 1. Their length should be equal to the bottom width or $6\frac{1}{4}$

inches. The velocity will be 0.70 of the velocity actually read on the chart, or $0.70 (14.9) = 10.5$ feet per second.

It will be noted that the chart provides for velocities V up to 50 feet per second. However, velocities above 25 feet per second are extremely difficult to control and ordinarily will require careful design for conveyance structures if satisfactory results are to be expected. High velocities generally require the use of velocity dissipators at the outlet end of the channel. Another factor that may affect design under conditions of high velocity is entrainment of air in the water. Water flowing swiftly down a long flume does not follow invariably the continuity equation $Q=AV$ for any value of A assumed. Air entrainment may expand the water to such an extent that the computed cross sections will be inadequate to carry the design discharge. It is for these reasons that the higher velocities shown in the chart should be used with caution and not indiscriminately applied to any and all conditions encountered in the field.

Attention is also called to an item which is sometimes neglected in design, namely, that in high-velocity channels the slope is often far in excess of that required to discharge the water at its initial or entrance velocity. This will cause the water to accelerate until uniform flow exists. The chart is based on a condition of uniform flow and mean velocity for the various slopes shown. In design, therefore, it will be necessary to investigate and allow for entrance losses in order that the full design capacity of the channel will be utilized.

IF terraces are to pay dividends, a systematic maintenance program must be provided and carried out on every farm on which they are used. The construction of even a well-designed system of terraces does not in itself assure complete erosion control. Construction is only the initial stage, and the success of terraces in erosion control depends on whether they are properly maintained and farmed after construction. Too often erosion-control efforts cease after terrace construction, and consequently, the expenditures involved are wasted. This is true of both the old terracing areas in the South and the newer ones in the Central and Northern States. Even in some of the earlier soil conservation demonstration projects the importance of terrace maintenance was overlooked and not adequately provided for in the development of the initial field programs.

The rapid rate of decline in the capacity of terraces—

MAINTENANCE OF THE DRAINAGE-TYPE TERRACE

By A. Carnes¹

and the capacity is a direct measure of their value—is well illustrated by the following example: A field of approximately 45 acres was terraced on a cooperator's farm in one of the Soil Conservation Service demonstration project areas in the winter of 1934. When completed, these terraces were carefully checked and

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Close-growing vegetation filters silt from the run-off, which concentrates in this depression between terraces and protects the channel from dangerous deltafication.

found to be up to specifications in every respect, with ample channel capacity to take care of the expected volume of run-off. During the following year improper tillage and maintenance practices were followed. The project manager, noticing the results, had the terraces rechecked very carefully early in the spring of 1936. The results were astounding. Instead of having ample channel capacity as originally constructed, many sections were found in the terraces where the capacity had been reduced by more than 50 percent. This meant that with the next heavy rain the terraces would overtop and thereby aggravate rather than alleviate erosion.

The good effects of proper maintenance are just as striking as the ill effects of improper maintenance. Terraces have been observed that were even slightly undersize immediately after construction, but with proper maintenance they were soon brought up to adequate size and this section was easily maintained year after year. Some examples have been observed where the capacity of terraces was actually increased year after year due to the maintenance practices followed until the terraces became entirely too large. Results at the soil and water conservation experiment stations have also shown that this is possible by a certain manipulation of regular cropping and tillage operations.

In the development of farm or district erosion-control programs, terrace maintenance must be given due consideration and provisions made to facilitate its establishment as a regular farm operation at the outset. Where soil conservation demonstration projects failed to provide for terrace maintenance work in the devel-

opment of their initial field plans the results were discouraging. The farmers who were not impressed with the need for terrace maintenance or shown how it could be accomplished as a regular part of their tillage operations, failed to appreciate its necessity and their terraces deteriorated rapidly. By the time the seriousness of the condition was recognized and supplemental maintenance methods developed, demonstrated and adopted by the farmers, terraced fields suffered seriously and many required rebuilding.

In other project areas, extra large terraces were purposely constructed to offset the expected lag in terrace maintenance work. This procedure was particularly tempting in areas where terracing was a new practice. It usually doubled or tripled terrace construction costs and in the end failed to secure adequate maintenance. This policy is still being followed in some areas and as yet its shortcomings have not been fully realized. To the more alert observers the fallacy of devoting excessive funds to construction in order to compensate for inadequate maintenance programs is clearly evident. The only logical procedure is to include terrace maintenance as a definite part of the original conservation plans and provide necessary facilities for its development, demonstration, and adoption, so that maintenance will be appreciated and practiced from the outset.

Terrace maintenance may be divided into two component parts: (1) The use of proper conservation practices, particularly contour tillage and close-growing vegetation, to check erosion and retain the silt on the terrace interval, thereby preventing deposition in the terrace channel below; (2) the use and manipulation of tillage equipment which produces lateral soil move-



The value of this terrace has been largely destroyed by excessive silt deposition in the terrace channel.

ment, such as plows, disks, etc., so that soil deposited in the terrace channel can be worked out at regular intervals.

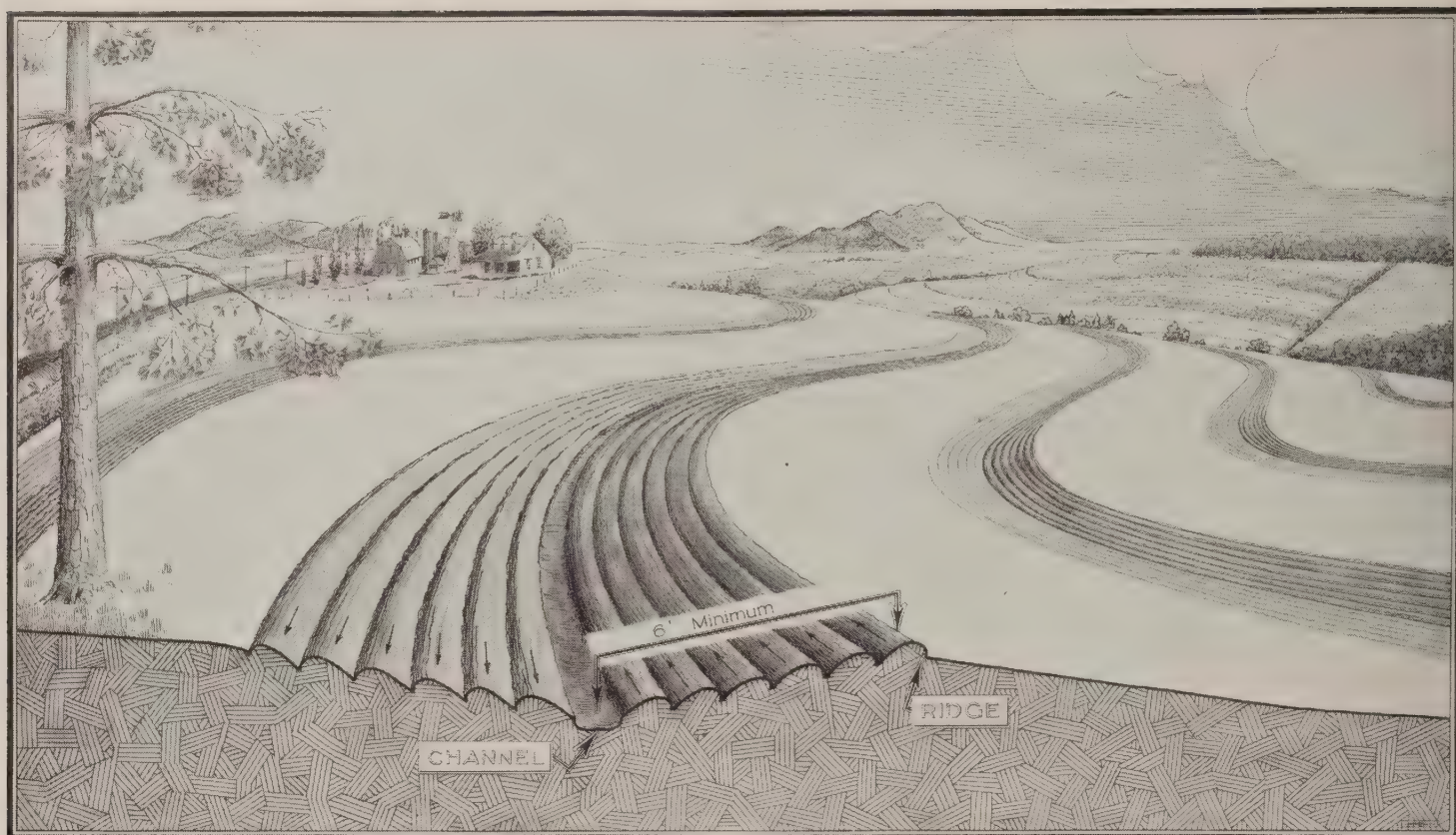
The ideal objective is to develop the first part to such a degree that soil movement is checked or the soil filtered out before the run-off reaches the terrace channel. This is not always practical under some field conditions. Even contour operation of most tillage equipment over a terraced field has a tendency gradually to reduce the size of terraces, so that it is usually necessary to rely upon the second part to provide necessary supplemental maintenance. Where good farm conservation practices are followed, sufficient supplemental maintenance can generally be provided by proper manipulation of regular plowing operations. Where erosion inducing practices are followed, additional supplemental maintenance in the form of grader or scraper work is usually necessary and, in most instances, adequate maintenance becomes impractical.

Contour cultivation and the use of close-growing vegetation are two of the most effective conservation practices that aid terrace maintenance. These are now commonly accepted as standard erosion-control practices, and they need little additional elaboration. It has been shown that an arrangement of close-growing strips of vegetation, on the terrace interval and immediately above the terrace, will aid a great deal in preventing silt from entering the channels. Strip cropping can usually be molded into the regular farming operations and crop requirements. Where diversion ditches, or diversion-type terraces with wide spacing, are used it is essential that a sufficiently wide permanent strip of close-growing vegetation be main-

tained immediately above the channel to protect it from excessive silting. The entire terrace interval on badly eroded areas or critical slopes should be planted to close-growing crops.

Throughout the cotton and tobacco belt of the Southeast, small depressions commonly occur in the terrace interval. Some are natural while others are the result of erosion. Accumulation of run-off in these depressions often leads to dangerous deltafication in the terrace channel where the concentrated run-off is discharged from the depression. Observations on several projects in this area indicate the advisability of seeding these depressions to close-growing vegetation so that the silt is filtered out before it reaches the terrace channel. This practice has decreased the number of terrace failures and the amount of hand and plowing maintenance required during the cultivation season. In the Southeastern States, proper row arrangement with reference to the terrace channels has also facilitated terrace maintenance. A row is placed on each side of the channel leaving a 4- or 5-foot middle so that the flow line will be left open during the cultivation season. At the last cultivation, when necessary this wide middle may be plowed out with a moldboard plow to provide for heavy rains in late summer.

The carrying capacity as well as the shape of the terrace can be improved by proper plowing methods. Considerable ingenuity must be exercised by the plowman in the manipulation of the plow and the location of deadfurrows and backfurrows so that the channels are maintained and terrace cross sections improved. This may be done by either the one-land or



One-land method of terrace maintenance.

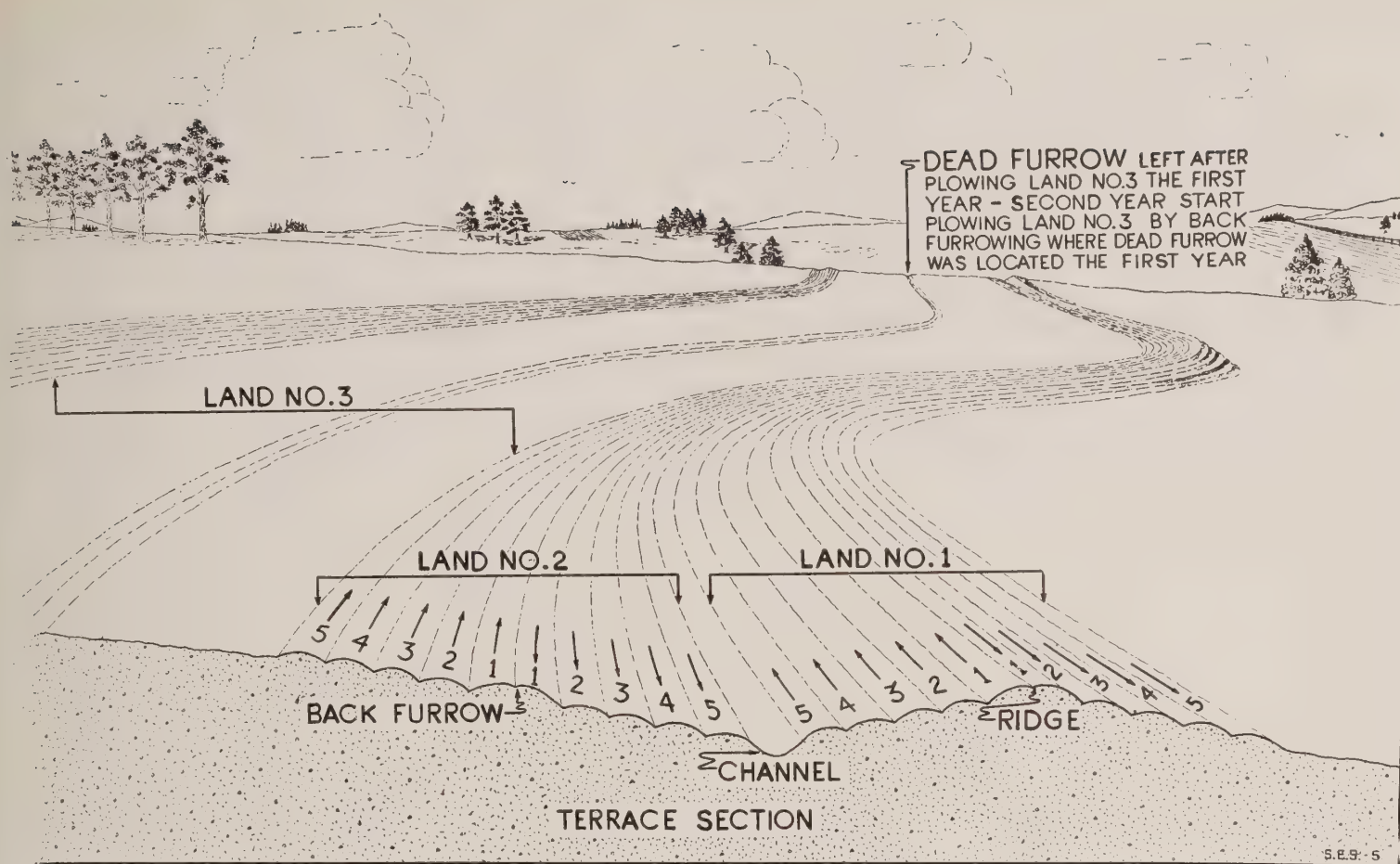
the two-land method, as illustrated in the accompanying charts. Minor variations may be necessary in some areas to meet local conditions. When land is prepared by flat breaking or complete plowing, the two-land method is admirably adapted, and maintenance becomes a part of land preparation. In areas where flat breaking is an annual practice and erosion is not severe, this procedure will usually provide adequate maintenance. When more severe silting has occurred in the terrace channel, two plowings may be necessary to obtain sufficient cross-sectional area to accommodate the expected run-off.

The one-land method has been developed and adapted by the Soil Conservation Service in the Southeastern States because of certain local conditions, but it may be adapted to other areas where similar conditions prevail. It has proved most practical where the rotation and tillage practice is such that the entire field is not plowed up in the fall or whenever maintenance is necessary, where erosion is more severe and supplemental maintenance is required between the regular plowing intervals, and where terraces are slightly undersize and additional plowings are necessary to provide adequate capacity. With the one-land method less plowing is required, but proper emphasis is placed on the channel and the undisturbed vegetation immediately below the channel affords considerable protection in case the terraces should overtop during the rainy season.

From the accompanying illustration it will be noted that the first furrow is thrown downslope at the lower edge of the channel. In the Southeastern States the second furrow is thrown upslope 12 to 18 feet from the first furrow. The distance between these two furrows will depend on the slope of the land. When this strip is plowed out, the deadfurrow will fall at the flow line. The outside furrows of this strip should be plowed deep and close, decreasing the depth and increasing the width of cut as the flow line is approached. This procedure will produce a broad-shaped channel.

In Region 2 it has been found that terrace maintenance should begin as soon as fall crops are harvested. Power and labor are available at this season, and in most instances the majority of the terraces can be maintained before January 1. If maintenance is delayed until the spring season seedbed preparation will compete with terrace maintenance and often the terraces will not receive proper attention.

The time when terraces should be maintained will depend, to some extent, on the rotation that is prescribed. For example, if grain and lespedeza are to follow cotton, it will be 2 years before the terraces can be maintained without destroying a strip of lespedeza. In this case, the terraces should be maintained before the grain is planted in the fall. This will ensure adequate channel capacity to control the run-off while the grain is making sufficient growth to protect the terrace interval.



Two-land method of terrace maintenance.

From experience in Region 2, it is concluded that field demonstrations followed by individual contacts give most effective assurance that proper maintenance will be carried out by the farmers. In project and camp areas, the cooperators are called together in each community for a field terrace-maintenance demonstration. Previously the technician has arranged for plows, teams, and drivers. One or two terraces are maintained while the cooperators observe the work. While the plowing operations are being carried on the technician explains each step as it is completed. This gives the technician an opportunity to explain the proper shaping of the channel with horse- or power-drawn equipment. During the demonstration the technician emphasizes the fact that terraces should be maintained before the rush during the planting season in the spring.

Following the demonstration, individual contacts should be made with each cooperator present at the demonstration to further assist him with the details of terrace maintenance on his farm.

Field meetings of cooperators immediately after heavy rains, to study the results of the various erosion-control practices, afford an opportunity to emphasize the importance of proper terrace maintenance. On these group tours, fields should be inspected where terraces have been properly maintained and are func-

tioning properly as contrasted with other fields where maintenance has not been obtained and damage has occurred. This procedure has been very effective in project and camp areas throughout this region.

In conclusion, each technician should understand (1) the details of terrace maintenance and how to assist in obtaining compliance, (2) the use of vegetation and its placement as an aid in preventing silt from reaching the terrace channel, (3) slope and soil conditions under which terraces cannot be maintained economically, and (4) the devices for establishing terrace maintenance as a part of the regular farm operations

D. J. Gardner, Extension officer for the Union of South Africa, gave the following account of terracing work to a local newspaper, "The Kokstad Advertiser," upon his return from a recent inspection trip to the British Isles, the Continent, and America. He said that terracing went through a period of transition. He had come to the conclusion that if one were aiming at permanency one must build the broad-base terrace. The day of the narrow-ridged type of terrace was gone; they needed the broad-base type and the whole of the terrace must be cropped like the rest of the field. After construction the terrace must be supported by proper strip-cropping, well planned rotations, and generally, good farming practice.

AGRONOMIC MEASURES OFTEN REQUIRE MECHANICAL SUPPORT

By C. R. ENLOW¹

THE agronomist who has had the opportunity, during the past 5 years, of studying the erosion problems on the croplands and pastures of this country and the agronomic measures that have been employed on soil conservation demonstration areas must indeed be a specialist of narrow perspective if he has not yet learned to appreciate the engineer and the importance of engineering methods in erosion control.

The engineer is anxious to do his part and generally is most willing to give full cooperation to the agronomist, the forester, and the other technicians. He has learned to appreciate the importance of vegetation as a supplement to his mechanical structures. Sod strips to filter out the soil so it will not clog the diversion channels; grass, shrubs, or trees to anchor the soil around a drop inlet, a dam, or a terrace outlet; close-growing vegetation in a waterway to prevent scouring; grass or vines to protect a steep embankment—all these are essential to practical, economical soil conservation engineering.

In planning a soil conservation program, the water disposal system should be the very backbone of the physical problem. When the engineer is required to plan the handling of excess water on scattered farms, without opportunity to make an over-all plan, the advisability of working on a watershed basis immediately becomes apparent. If, as quite frequently happens, a farmer wants a soil conservation plan, and the surplus water from one or more farms above him is rushing across his fields, what should be done? If his farm is to be considered singly, the engineer undoubtedly will be obliged to install an expensive diversion channel (provided he can find a satisfactory outlet for the water) before any erosion-control measures can be successfully employed on the farm. Working on a farm here and a farm there greatly complicates the problem. If the engineering plans for the entire drainage area can be prepared as a single unit the results are more economical, satisfactory and permanent. The engineer, when attempting to plan a particularly difficult water disposal system on a single farm, may realize with misgivings that his professional forebears

in the early days laid out this country on the square. Most certainly the fact that we must practice "round farming in a square country" now is a problem for all those interested in furthering the cause of soil conservation, whether they have specialized in engineering, agronomy, forestry, farm management or wildlife control. Certainly the problem is particularly trying for the engineer.

Agronomic methods of erosion control quite frequently must be supported by engineering practices. What agronomist of today would attempt, under the conditions cited above, to control soil erosion by strip cropping without first insisting upon the installation of necessary run-off diversion measures? Many such mistakes were made in the past with the result that engineers had to divert the water by building structures after the strip cropping program was put into effect. The ultimate result was increased costs and much inconvenience to all concerned. It is to be hoped that the agronomist has profited by these mistakes and is insisting that the engineer have an opportunity to contribute in the very first planning.

Approximately 1,000,000 acres of cropland within the boundaries of Soil Conservation Service and C. C. C. work areas are now farmed by contour strip cropping. Today, on many farms where it was formerly thought that contour strip cropping would successfully control erosion, diversion terraces or regular farm terraces are being installed to supplement strip cropping. Why? Merely because we did not know too much about strip cropping, and in our enthusiasm we expected too much from it.

The agronomist who is willing to recommend contour strip cropping to control erosion on a long, badly eroded slope with a distinct erosion pattern already established and the topsoil mostly gone, is being too confident about something he does not understand. Unfortunately there are many such errors on our soil conservation projects today. Under such conditions, engineering work—terraces or diversion terraces, depending on the slope, soil and other factors—should be the framework on which to build. It is impossible to continue to crop such land and improve or even

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Terraces are essential in a badly eroded field with a distinct erosion pattern, to prevent the accumulation of water which would destroy the vegetation. The combination of terraces and strip cropping gives very satisfactory erosion control.

maintain soil fertility without engineering aid. With the terraces to break a long slope into several short ones, to prevent concentration of water into countless depressions down the slope, and to be used as guides for contour cultivation, the chances of success look much brighter. We can scarcely afford to endorse a program for erosion control unless it at least appears permanent on the surface—and the addition of the terraces adds the touch of permanency. If the agronomist has not overlooked mineral deficiencies, a real erosion-control rotation with proper tillage practices, land conditioning for legumes and grasses and some of the other highly important fundamentals of agronomy, the chances that a permanent program will result are much improved. Methods of terrace construction and maintenance have improved tremendously in the past 5 years, and an efficient and conscientious farmer will find little difficulty in the maintenance of terraces that have been properly installed.

Frequently a situation is found where bottomland cannot be properly farmed until erosion from adjoining slopes, whether pasture or cropland, is stopped. If the land is cropland the problem may be similar to that previously described; but if it is in a serious condition from erosion it may be necessary to take it out of cultivation and return it to grass or trees. Under such conditions, contour furrows or terraces are frequently necessary to obtain immediate control while a good cover of vegetation is being reestablished through proper management. It is not uncommon to find permanent pastures on abused and neglected slopes that are erosion hazards almost equal to any that can be found on cropland. Terracing is a necessity and it can be justified on pastureland where valuable cropland is being protected by the same practice.

The value of engineering in water conservation is

so generally recognized that comment is scarcely necessary. In semiarid regions, contour furrowing is an accepted practice in preventing run-off and saving the limited rainfall for the increased production of vegetation. If the rangeman can succeed in carrying out a grazing plan that will give the vegetation a chance, his efforts combined with those of the engineer will go a long way in preventing water and soil losses. The engineer's work in constructing dams for watering places, to provide better distribution of livestock and thus prevent overgrazing in areas adjacent to the present sources of water, is recognized as a real contribution to the program.

The agronomist is always ready and willing for the engineer to step to the front when a deep gully is eating its way into a field, or where water must be let down a slope so steep that the velocity of flow is too great to permit revegetation. The disposal of flood waters and of accumulated water from highways, are engineering problems that must be solved before the agronomist can successfully effect his phase of the program. The real test of engineering-agronomic cooperation comes, however, on the sloping eroded fields as previously described, where even the combined efforts of both may be found insufficient to meet the problem of rehabilitating the land for continued and permanent cultivation.

The agronomist working in the soil conservation program has learned to respect the engineer. It is not at all uncommon to hear the engineer emphasizing the importance of the rotation of crops, the advisability of using specific grasses, or the necessity of soil conditioning in order to produce vegetation. Facing practical farm engineering problems, the engineer has shown a versatility that is commendable and a resourcefulness that is admirable.

SOME ENGINEERING ASPECTS OF THE WATER FACILITIES PROGRAM

By H. T. Cory¹

THE development and construction of water facility projects is being carried out during the current fiscal year under the so-called Water Facilities Act of August 28, 1937. The program is financed by \$500,000 included for this purpose in the 1939 appropriation to the Department of Agriculture. The Secretary of Agriculture, recognizing from the experience of the Farm Security Administration that many rehabilitation clients can accomplish their own economic reestablishment if they are provided with loans and technical help for the construction of small water facilities, has allotted \$5,000,000 from the emergency relief appropriation of 1938 for water conservation, dams, reservoirs, pipelines, well digging and drilling, and other small facilities for water storage and utilization, in furtherance of rural rehabilitation and relief to needy farm families. As a result of this arrangement, however, certain limitations are now in effect to carry out legislative provisions which are not common to both the Water Facilities Act and the Emergency Relief Act of 1938. The three most important are (1) that no more than \$50,000 be assigned to any one project, (2) that projects are to assist farm families of low income, and (3) that Federal funds for construction be loans rather than grants. How profoundly these limitations will affect the administration of the Water Facilities Act after the current year remains to be seen, but for the present they are adequate.

It has been determined, and administrative instructions have been issued accordingly, that allocation of funds for projects and the approval of such projects will be in the hands of a Water Facilities Board composed of representatives of the Land Use Coordinator's Office, the Bureau of Agricultural Economics, the Farm Security Administration, and the Soil Conservation Service. These agencies will formulate and carry out the administration policies while the Soil Conservation Service will execute the program, designing and carrying out the actual constructions. Such an arrangement automatically diverts a large share of the

major field responsibilities to the engineers of the Service.

There are two ways of constructing water facilities to assist a farmer under the Federal plan. The Department may decide to supply the funds for a farmer-built facility, accepting a note and arranging for its repayment according to the farmer's ability to pay, the Soil Conservation Service engineers acting only in the capacity of consultants or supervisors of construction. Or instead, the actual building may be done by the Soil Conservation Service, with the financing plan and collections remaining a separate responsibility of the Farm Security Administration.

Loans based upon the construction costs are to be made and approved before any field work is begun. Estimates of such costs are an engineering responsibility and must be reasonably accurate in spite of the unknown factors involved. Farm conservation plans are to be made and enforced as a part of the several projects, but the engineering structures will be the features around which the whole program hinges and their success or failure will determine to a large extent the future of the entire endeavor.

Under the program, loan applications doubtless will be made for projects varying greatly both as to their nature and their cost. Probably no engineer or engineering organization at any time or in any place has been called upon heretofore to treat with such a diversity of projects, hydraulic in their nature, as will confront the Soil Conservation Service engineers. Allotments will be made for installation or construction of facilities which will provide livestock or irrigation water; collect supplies from precipitation, springs, water tunnels, underground streams and reservoirs, and surface sources; recharge subsurface water-bearing strata; and run the complete gamut of water storage developments. The facilities must also have useful lives of predetermined duration and they will entail a tremendous variation of costs per quantity unit of utilizable water output.

Thus the task imposed upon engineers for designing and constructing or supervising the construction of

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water facility projects will be out of all proportion to the relatively small total expenditures. There will be no glamour of monumental size, of large scale mass production adaptations amounting to inventions, or of tourists detouring from main thoroughfares to see marvels of engineering. It will all be comparatively drab work. Yet much of it, to be well done, will require the highest type of engineering ability.

This is peculiarly the case because the immediate beneficiaries must, to the limit of their capacity, repay with interest the Federal funds going into projects, overhead excepted. It is not a matter of spending other people's money and "doing it right regardless of expense," but of handling jobs as trustee for a lending agency on behalf of a borrower who through lack of funds must place operations for his particular benefit unreservedly in the hands of such lending agency. All borrowers will probably be in the low income farmer group, and a little added bad fortune or unnecessary expense may destroy entirely their insecure status as independent farm operators.

Thus it is that mistakes as to designs, as to results obtained, as to estimated costs, as to useful lives of structures, and as to maintenance and operation expenses must be at an absolute minimum. Otherwise, in addition to much avoidable mental anguish, black marks will be chalked up against a movement of social import designed to help some of those struggling to retain their economic independence. From these several considerations one may obtain a realization of the peculiarly exacting responsibilities which the immediate water facilities program places upon the engineers who will be called upon to design and construct water facility projects.

These projects may be classified in a good many ways—as to purpose, sources of water supplies, structural means of securing desired results, etc. There are several equally important features of the engineering work, viz, designs of works suitable to the requirements and conditions, organization, labor, decisions upon equipment requirements, proper machinery and materials, supervision of construction work, etc. In this résumé, however, only the design aspects of projects classified as to supply of (1) underground waters and (2) surface waters, will be considered.

The amount of water which for any length of time can be obtained from undeveloped underground sources is never accurately predictable and often only within very wide limitations. Much the same is true regarding depths to water-bearing strata. Unfortunately, the common idea that continuing small seeps of water from hillsides and swampy areas can be "developed" into yielding significant amounts of water

often proves erroneous. Nevertheless, tunneling and other enlargement efforts sometimes greatly increase the water yield. The local geology is the significant feature. Since few engineers are experts in geology, and since most Soil Conservation Service regional staffs include at least one and sometimes several specialists in geology, their opinions should be secured before starting to develop water seeps. Much the same is true as regards wells. Hard or even slightly brackish water is better for domestic livestock use than water hauled long distances. Therefore water quality, excepting surface pollution of course, is usually a minor consideration with respect to water supplies for this purpose; the chief considerations usually are necessary supply and the least expensive casing and pumping equipment for satisfactory and lasting use.

Usually, wells for irrigation water supplies must yield relatively large amounts of water—0.5 cubic foot to 4 cubic feet per second (225 to 1,800 gallons per minute). Except in proved areas, the output and "draw-down" (the depth to which water in the well is lowered while pumping) are seldom predictable except within wide limitations, a fact which should be impressed upon all concerned, especially the borrowers for such types of water facility projects. Drilling wells for large water yield is a very specialized business, and capable contractors usually are conservative both as to advance yield estimates and unit prices for work. Probably of all engineering activities which are susceptible to contract, well drilling offers the greatest complications in complying with governmental regulations as to contract work and, at the same time, in securing good work at low costs. If, as may well happen, the water facilities program as tentatively approved includes drilling many wells scattered over an immense area, the Soil Conservation Service engineers will face a situation without precedent. In such a case the methods and procedures used in getting well-drilling work done will be watched closely by a large group of the country's technical men.

Another interesting fact is that it will be necessary to estimate the useful life of the well. Estimating the useful life of a well is by no means common. It involves estimates, it is true; but it also involves guesses as to quantity of water which will be collected, amount thereof which will get back into the local water-bearing strata, total accretion to and depletion of the underground water body tapped, probable change and rate of change in water quality, corrosion rates of well casings, plugging of well casing perforations from several causes, caving in, sanding up, etc.

Relatively few wells will be artesian, that is, flowing.

Water must be pumped from those which are not. A complete well unit is often considered as including not only the well, but all the pumping machinery and related power plant. Nevertheless, water wells and the pumping plants to take water from them belong to quite different classes of engineering. Wells may safely and continuously yield much more water than the pumping installation can handle and vice versa. The output of the complete unit is determined by the capacity of the minimum controlling element, hence it is important that the two should be properly balanced for economical and satisfactory results.

To secure such balance is not simple. The completion feature of sinking a well is the testing of the output for a continuous yield of 24 to 72 hours. It is not practicable to require a longer trial period, and usually portable pump outfits are used for such tests. Only after the results of such tests are known can an intelligent judgment be made as to the capacity and type of the permanent pumping equipment which should be installed. Even then the water output may gradually increase or decrease for a long time and thus throw the two parts of the total installation out of balance.

The type, efficiency, and durability of pumping equipment are exceedingly important. Most pumps, and power units driving them, have high efficiency over narrow ranges of quantity output, but this efficiency decreases rapidly when the work is either lessened or increased. This is an added reason for careful balancing of the equipment to the water yield. Also, there are sharp differences in the durability of pumps and especially of pump runners, if any sand is carried by the water.

Nevertheless, it is necessary to make advance estimates of the total cost; and, on such estimates not only must both the farmer and the Federal agencies decide upon the desirability of projects, but also through them obligations must be executed by beneficiaries before work is started. If advance estimates are too high, desirable projects may be rejected as too costly, and if too low the deficits must be made up from Federal funds.

In planning for the storage of surface waters, the designing engineer is always confronted with three chief dangers quite unlike the considerations he takes into account when planning for well installations. These are (1) overestimating the amount of water which can be caught and retained, (2) underestimating the size of great floods and (3) underestimating deterioration, particularly from silt deposition.

A reservoir which becomes empty or nearly so during droughts is an asset of questionable value, although it

may be better than none at all. Nevertheless, few things are more disconcerting than a water supply which fails when most desperately needed. The so-called "wetness" of years varies greatly, as do the cycles, so that for periods of several years the rainfalls are subnormal; the evaporation is excessive and the watersheds become thirsty and absorb much and often all of the very little rain which does occur. Furthermore, a larger drainage area than necessary means greater and perhaps excessive spillway costs. Variations in the water yield from relatively small watersheds may be almost unbelievably wide, and engineers and others who refuse to accept the relevant data frequently make gross overestimates of the amount of water which can be collected in critical periods. The danger is less with larger watersheds, as these usually have stream-discharge records extending back from 10 to 50 years.

Most small water storages are created by earthen dams which if overtopped by floods are damaged or completely destroyed. Intense, short, local rainfalls of the cloudburst variety are characteristic of arid and semiarid regions. It is only a question of time when such a storm will occur over any given small drainage basin within the region where water facility projects will be built. Present knowledge of such matters is so meager that the designing of spillways around earthen dams, for effective protection and yet not prohibitive in cost, is a grave problem. It tests the capacity of hydrologists to the limit.

Sometimes such spillway problems may be avoided if the storage reservoir is located quite outside the main drainage basin and where there will be a very small water collecting area upstream from it, and if the water is conducted to the reservoir through a supply canal heading in the main stream. Such a treatment will prove desirable where the supply canal can be short and cheaply built, and the diverting works on the stream whose waters are to be diverted can be simple and inexpensive. Since in a good many instances ordinary spillway provisions will represent as much or more than half the total cost of storage facilities, the possibilities of off-stream storage will frequently merit investigation. Again it is a matter of judgment. Indeed an unusual amount of the engineering work on water facilities projects will not lend itself to determination by formula and mathematical examination.

The ultimate destiny of all reservoirs storing surface run-off is that they will be filled with silt; the only question in any given case is how long a time will be required. The useful life usually will be considerably

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IRRIGATION AND THE CONSERVATION OF THE RANGE

BY W. W. McLAUGHLIN¹

NEARLY all life—human, animal, and plant—depends for its sustenance upon air, food, and water. Of these three essentials, water is the scarcest in the western part of the United States, and consequently the controlling factor in food production. The whole industry of the arid region is built around and must be limited by the water supply. Our problem thus resolves itself into the utilization of the water supply for the greatest good to the greatest number, and the question of land use becomes in a measure secondary to that of water use.

In the planning of range conservation and irrigation, there are two aspects of the question that must be given full consideration. These are (1) the principle of long-time use planning, keeping in view the greatest good to the greatest number, and (2) the immediate aspect and the individual human benefit that cannot be divorced from the picture. In other words, we cannot disregard the immediate future in planning for the ultimate future. Neither can we place too much emphasis on the academic planning, unless we first give serious and justified consideration to the practical application and consummation of the plan.

In considering the utilization of our water supply for the conservation of the range and for irrigation, we must be ever mindful that the problem is dynamic and not static. Changes have occurred in the past and will continue to occur as a result of changing economic conditions. Changes in climatic conditions are also important. It must be kept in mind that there may be a more important use of water than for aiding in the maintenance of the range, and even for irrigation. Water is demanded for municipalities, for industries, for farming, for grazing, for wildlife, and for recreation. In nearly every State a preferential right to the use of water is specified, the first right being that of human consumption, then agriculture, then industry, etc. But a force even greater than these legal restrictions develops in the economic conditions resulting usually from increased population, increased industrial activity, and other demands which can afford to pay more for water than can the range or the farm.

In what ways are range conservation and irrigation interdependent? The problem has been stated thus: In the range areas of the West how many acres (10, 40, or even 100) of rangeland is necessary to maintain one animal? But, in the irrigated section the question is asked quite differently: One acre of irrigated land will support how many animals? On the range, for the most part, there is a time of the year in which the animals cannot be grazed, and fodder must be provided from some source to maintain them during this period. Under the Taylor Grazing Act, and the Forest Service regulations, one of the limiting factors to the number of animals that may be grazed is the amount of feed the applicant produces for the "winter carry-over." This feed in the West is grown for the most part under irrigation. In years of unusual drought, such as 1934 and 1936, there was practically no feed produced on the ranges in several regions, and it was necessary to dispose of the animals or to move them where feed could be found. This meant usually moving the animals to an irrigated area. There is a limit to the distance animals can be moved with profit, and there is a limit to the distance to which feed can be moved. It naturally follows that to make the best use of the range it is desirable to have feed available within a reasonable distance of the range. Likewise, in order to enhance the carrying capacity of the range it is necessary to increase the amount of feed the range is now producing.

Range management and irrigation agriculture are closely related in much of the West, yet the livestock grower has often looked askance at the prospect of farming the land intensively. He knows that it must be done for his own good; but is willing and eager to leave it to someone else. In common parlance, he prefers to "farm on horseback." So we find various communities in which the livestock growers have engaged in irrigation farming as a necessary evil, to provide the feed which they need to supplement the range.

Kanab, Utah, with its limited irrigated agriculture centering around and absolutely subordinate to the dominant livestock industry, typifies such a situation. Many other examples of the relationship between live-

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stock production and irrigation agriculture might be cited. The Vale irrigated area in eastern Oregon is a typical area in which an irrigation project supplements the ranging of livestock. In Colorado and western Nebraska, as elsewhere, feeding of livestock is an essential part of the irrigation project economy.

There are two major possibilities for the employment of irrigation in the conservation of the range. First, there is the irrigation of the range itself, which of necessity would be very limited in extent as well as spotted in most regions. The second possibility—and we might say necessity—is the creation of more irrigation units to be coordinated with the utilization of the contiguous range.

In the first possibility, there is little likelihood of there being anything spectacular done, since the works required are of minor engineering importance, although in the aggregate the increased fodder production may be in many areas most significant.

For example, there are many areas where flood water flowing down broad valleys or coulees can be diverted, and the water so diverted let flow where it will, or directed by inexpensive and usually short ditches over bottomlands adjacent to the streams. The areas that lend themselves best to this type of development are those in which there is relatively little fall to the lands or to the stream. In the plains area, an excellent example of this type of irrigation is to be found on the Souris River, in north-central North Dakota. There are numerous instances throughout the West, in areas which for the most part will probably always be used for grazing, where this practice could be effected and the amount of fodder greatly increased. In years when the range affords ample pasturage, these flooded areas could be cut for hay and thus a reserve of feed built up for years of drought.

In many mountain valleys, especially in the upper parts of the watershed, it is possible that the diversion of flood water on to less steep grazing areas would serve a double purpose of increasing the fodder growth and reducing the spring run-off of water. There are also many upland meadows where improvement could be made in the fodder production, through a limited amount of drainage coupled with the diversion of water from the natural channel around the edges of these meadows. Some of the small upland lakes could be made into reservoirs, and their waters released later in the season for irrigating the upland pastures. The water from springs likewise could be distributed, and while the total area so covered with water might not be great, yet one acre of partially irrigated land would produce many times the amount of fodder

grown on one acre of nonirrigated range. Some of these upland reservoirs, when so constructed, might be utilized to develop a small irrigation unit within the grazing area itself. In some parts of the range water holes and small reservoirs for stock-watering purposes could be constructed, and when properly located throughout the area would tend to prevent overgrazing of areas immediately contiguous to springs, running streams, or the occasional water hole.

In some areas, for instance in parts of Nevada, the Great Plains, and elsewhere, there is to be found underground water which may be pumped and used either for the irrigation of limited areas of land or for the creation of facilities for stock watering. While some of these developments, especially those involving underground water, may within themselves seem prohibitive in cost, yet when considered in conjunction with the range they may be found entirely justifiable from an economic standpoint.

I often recall an incident that happened some years ago when a stockman called at my office in Berkeley, seeking our assistance in designing a pumping layout to irrigate some 40 acres of land in the High Sierra which was to be seeded to alfalfa. The pump lift was to be about 130 feet. My immediate reaction was that the lift was too great, and consequently the cost of producing hay beyond the economic limit. But this sheepman soon convinced me that it was much cheaper to pump water 130 feet to grow the small amount of feed necessary to carry his flock over than to ship the sheep out or ship hay in at \$30 per ton.

However, the principal place of irrigation in the conservation of the range is its practice in a truly irrigated area. As previously indicated, neither the stockman nor the dry farmer adapts himself readily to irrigation farming. The irrigation unit provides fodder for the range stock, not alone to carry them through the winter and through drought periods, but to provide both hay and grain for the fattening of animals for the market. The range animals afford the irrigation farmer a market for at least a part of his produce.

In our recent survey of the San Luis Valley in Colorado, which was originally and entirely a livestock country, we found that out of some 600,000 acres of irrigated land about 283,000 acres was in wild hay and pasture, and, further, that this wild hay and pasture is irrigated almost entirely with flood water. But it is irrigated.

One phase of range maintenance and conservation that has been more or less disregarded is that generally spoken of as supplemental irrigation. The fact that this has been largely neglected may be attributed to

the antipathy of the stockmen toward farming, even to the extent of raising a family garden. "Supplemental irrigation," as here used, includes providing water with which to maintain the family garden and orchard, the raising of sufficient fodder for the family flock and herd, a few pigs, and the work stock. With such an irrigation layout the family is assured, even in times of extreme drought or some other range disaster, of sufficient food for themselves and feed for the operating livestock and poultry. It can be, and often is, a source of considerable income and, of course, is most valuable when prices for range stock are low or when for any other reason the profits from the range are lessened. This type of irrigation in conjunction with the range should be given much greater consideration in the future planning than it has received in the past.

It is not to be understood that any of the above practices can be entered into promiscuously, nor should the building of small diversion dams be undertaken or permitted in connection with the development of a range, until due consideration has been given to the relation of the particular dam to other developments within the range. There are instances where too many diverting dams have been constructed with improper guidance in their building; and too many small reservoirs have been constructed in too steep ravines or canyons and in dry washes. Mere storing of water in ponds without some definite use of the water so stored is not true conservation. In some areas, large numbers of dams have been constructed with no means of utilizing the water, which is simply allowed to evaporate. The conservation of the range presupposes coordinated planning, and that is essential in any development.

North Dakota's plan to rehabilitate the agriculture in its drought area is interesting. The western part of the State is devoted almost entirely to stock raising and dry farming, both of which were almost wiped out during the past 4 or 5 years of excessive drought. The last legislature of the State created a water conservation commission and made available to them \$112,500 for the next 2 years to lend for the purposes of irrigation. The Bank of North Dakota made available \$50,000 for the same purpose. With the thought that the irrigation projects in mind would serve as demonstrations, the bank loans are limited to \$1,000 and apply to areas of not more than 40 acres each. In the discussions and deliberations incident to the inauguration of this program, there was always brought out the coordination of this irrigation development and the livestock industry.

I have indicated in this paper that the range as it now exists is not stable, and I wish to call to your attention another particular in which there is likelihood of a change in our present grazing privileges on the range. In the arid region we must admit that the greatest natural resource is water. Anything that affects the water yield, either in quantity or in seasonable yield, has its effect on the value of that natural resource. In most of the West the area from which water is derived for all purposes is the watershed, usually in the high mountains. Therefore, the proper use or the abuse of this area is of vital importance to the water user, and I venture the statement that it will not be long until the water user demands and insists upon a voice in the control and use of the watershed. This means a voice in the control of grazing. Already in some few areas the water users have acquired title to the lands of the watershed. In others they have gone so far as to demand the discontinuance of some practice or practices that interfered with vested water rights. I do not see in this regulation of the use of the watershed anything especially antagonistic to the conservation of the area as a range for livestock, but it would certainly preclude the abuse of the grazing privilege.

SOME ASPECTS OF WATER FACILITIES PROGRAM

(Continued from p. 174)

less than the period required for complete filling by sediment. The establishment of adequate soil conservation practices in connection with all water facilities projects should materially increase their useful life. Thus, several factors must be evaluated before the final answer can be had as to the useful life of water facility projects which involve storage for surface waters. Each of these factors is largely a matter of experience and the final answer even more so.

In general, the smallness of such works introduces a different set of criteria and data than those which have been used for large works in the past. Practically speaking, engineers will break new engineering paths in designing and constructing a host of small water facility projects for surface-water storage and utilization. Only a couple of years ago the expression "upstream engineering" was coined for an essentially new type of engineering activity; namely, one dealing with hydraulic, hydrologic, and erosion problems on small watersheds. It now seems that, in carrying out their responsibilities in the water facilities program, conservation engineers may develop a new engineering field which will merit the cognomen "water facilities engineering."

ENGINEERING PLANNING IN FLOOD CONTROL

By E. R. Kinnear¹

THE scope of this subject is very broad and the space allotted limits the discussion to a brief analysis of flood-control planning within the policies of the Department of Agriculture.

The increased interest in flood control and related water problems has recently inaugurated extensive drainage basin studies which indicate the necessity for greater refinement and consideration of detail in comprehensive flood-control planning.

The watershed details with which we are most concerned are land use and management, soils, vegetation, sedimentation, flood flows from tributary streams and a more complete consideration of economic values. To evaluate properly these details in relation to flood-control planning we must have qualitative and quantitative analysis on a watershed basis. It is logical that surveys and planning should be carried out on a watershed basis, since a flood is a concentration of water and its accompanying sediment load occurring at a given point within a given time and resulting from the actions and interrelations of these elements on the given watershed.

It is essential that hydrology, sedimentation and economics—foundation stones upon which any flood-control plan must be constructed—be based upon all known measurable and constant factors. The unknowns and variables should be evaluated by the most acceptable technical procedures available. The differences of technical opinion as to procedure, and the permissible tolerance of accuracy in results, must be molded together. In some instances, long-time studies may be required in order to strengthen some of the approximation. In this manner, we can evaluate land use, water conservation and flood control in specific terms. Since erosion control and flood control are both economically subservient to land use, flood-control practices and supplementary works as designed and evaluated for the interest of the individual farm or area may be modified for the best interests of the watershed as a whole.

A comprehensive flood-control plan will involve nearly all human activities pertaining to land and water use. Thus it appears that a sequence of steps for formulating a flood-control plan should be indicated. It is suggested that an orderly approach is as follows:

1. Accumulation of physical and statistical data and an accurate classification and evaluation of damages.
2. The classification and evaluation of the elements contributing to damages.
3. The planning and designing of the most economical control practices for the prevention or amelioration of the damages.
4. The coordination of agricultural flood-control planning and designing with all other flood-control or water-use plans or developments in the watershed.
5. The evaluation of the benefits accruing from practices in terms of reduction of potential physical and economic damage.
6. The evaluation of the indirect benefits which would result from the establishment of control practices, with consideration of the long-time land-use and social problems within the watershed.
7. The balancing of the cost against the total benefits derived.
8. The determination of a suggested sequence of operations with allocations of budgeted amounts over the required period of years, looking towards a projected date of completion; and the determination of the most economical method of financing the construction of the control measures, giving full consideration to the private, State, and Federal interests involved.

It is apparent that a negative conclusion as to the feasibility of a plan may possibly be reached at any point in this procedure, or that a positive conclusion may result all the way through.

We are accustomed to think of floods in terms of damage which usually takes the form of erosion, sedimentation, physical damage by water or loss of life. This damage is generally expressed in terms of money or retardation of development through a sense of fear and insecurity which results in social detriment. The classification and evaluation of flood damages of record, and the analysis of the factors which produce each type of damage at each locality require a comprehensive and thorough study of the hydrology, sedimentation, and economics within the watershed—this in order that the extent and magnitude of potential damages may be more accurately estimated. A thorough physical and economic appraisal of past and potential flood and sediment damages is necessary for the entire watershed and is of primary importance. A segregation should be made between those damages

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caused by outstanding individual floods and those caused by numerous minor floods which are progressively destructive over a long period of time. The results of this appraisal will aid in determining the extent to which the additional physical and statistical surveys should be carried out.

These surveys will provide the data which are the tools that engineers must use to build up the plan for flood control. We can only briefly indicate here some of the indispensable basic data.

1. *Physical characteristics of the watershed.*—Sufficient information must be obtained to evaluate the topography, geology, soils, erosion, vegetation, and sedimentation with respect to their influence on the flood problem. From topographic maps, aerial photographs, geologic maps and data, we may determine the influences of these characteristics on surface run-off, ground water, erosion, and sedimentation. Detailed cross sections may be required for existing or proposed dam sites and reservoir capacities, and locations of other structures. Sedimentation cross sections and profiles of reservoirs on stream channels may be required.

Conservation surveys should provide pertinent information on soils, erosion, and cover. Soils information is of utmost importance—such as soil moisture (cyclic, seasonal, and associated with storms), infiltration rates and storage capacity limits; erosion characteristics, physical and chemical characteristics, and limitations with respect to vegetative productivity and its influence on maintenance of structures and channels, and soil-mechanics limitations for use of soil in earth structures. An appraisal should be made of permanent or semipermanent damages to soils—or the crop base—within the flood plain with respect to scour, bank erosion, sediment, and debris deposition.

2. *Meteorology and hydrology.*—Meteorologic analysis and synthesis for storm patterns will be required. Climatic characteristics in terms of the cyclic and seasonal variations and conditions to be expected during storms must be evaluated as to temperature, snow, ice, or frost. This knowledge is basic to the calculations of the relations between precipitation and run-off. The same may be said of the character of precipitation and its distribution—the cyclic, seasonal, and storm pattern characteristics, particularly the sequence of rates, areal extent, storm paths, and frequencies of occurrence.

From this information, the engineer will be able to make further determinations which will serve as a basis for actual design. Such determinations are:

1. The evaluation of channel and streamflow conditions with respect to the interrelation of loading of

streams, pondage, and hydraulic efficiency of conveyance channels (outside the zone of Army interests or within the zone if cooperatively studied).

2. The utilization of sediment production indexes in the watersheds, to evaluate past and potential damage to existing and proposed storage and flood-control reservoirs.

3. The correlation of specific damages with specific causes, to determine critical flood- and sediment-source areas and to develop the requirements for land-use readjustment, reforestation, soil conservation, highway and streambank protection, and additional mechanical flood-control works.

4. The expression of this information in hydrologic terms with respect to surface inches of run-off and surface inches of storage of flood flows as reflected by hydrographs of the “official plan” flood flows—those representing maximum phenomena against which provision can reasonably be made.

5. Evaluation of these data with respect to financial and other benefits to be derived by reduction of the flood peaks and damages, as a basis for selecting the final design of control measures.

With such basic information available (and whatever additions may be feasible) the engineer, economist, and associated technicians are in a position to evaluate the characteristics of flood-source tributaries. The flood-control relationships with land use, erosion control, water conservation, and forestation, as supplemented by feasible mechanical storage or detention structures, may be developed from the basic information as a basis for design.

Erosion-control practices and supplemental structures should be so designed as to accomplish optimum soil stabilization with maximum flood regulation. In designing structures, under the water facilities program, consideration should always be given to the possibility of modification of the design to provide added spillway storage to effect a measurable delay in the time of concentration and desynchronization of flood run-off.

A few examples may well be considered. It may prove desirable to redesign spreading dikes, terraces, ditches, contour furrows, and similar structures in order to provide a measure of flood regulation. Such redesigning is limited, however, by the allowable inundation time of the crops or vegetation involved, and by the value of the vegetation either as a crop or as a maintenance factor. In this, soil drainage is a pertinent factor.

There may be instances when land-use practices alone, such as strip cropping and grassed waterways, are sufficient to achieve optimum erosion control.

Permanent pasture may achieve optimum erosion control, but the installation of large water-spreading ditches and terraces on the pasture would provide a valuable measure of flood storage and delay in time of concentration. Such possibilities may often be limited by land-use economy, time of inundation of vegetation, climatic conditions, and other factors.

In certain instances the redesign of highway and railroad drainage may be an important contribution to flood control; but it must be considered always on a basis of economy as influenced by flood frequencies and damages involved.

There are areas where flood run-off from land of extremely low value and utility is causing severe damage to valuable lands below. Such areas may require land zoning and appropriate restrictions plus detention dams, mechanical controls which may cost more than the land is worth even though this cost may be well within the limits of the total economy involved.

There are instances where streambank and flood-plain erosion may not be affected by reduction of flood peaks, so that no modification in standard design for maximum flood conditions would be permissible.

In order to determine the technical feasibility and efficiency of a flood-control program on a quantitative basis, it is essential that some measure be used for drawing a comparison between existing conditions and the proposed controlled conditions. The assembling and routing of flood flows by the flood hydrograph method is a valuable yardstick currently used by engineers. This is applicable to individual structures from the small headwater areas, progressively to the whole watershed area, and such findings reflect the characteristics of flood flows under existing conditions and the probable characteristics of flows under controlled conditions. In both instances, the hydrographs may be based upon the characteristic maximum or official-plan storm for the watershed, which is determined from the meteorological data.

It is probable that all practices and structures will not be designed for the "official storm," since economy and common sense dictate that lesser storm frequencies be used for the design of certain types of practices and structures such as terraces, check dams in gullies, etc. However, the effects of all practices and structures during official-storm conditions will indicate their influence on sedimentation and flood flows.

In flood-control planning it becomes the duty of the engineer to use the basic information outlined in the previous paragraphs as a basis for estimating the rate at which excess flood waters will be delivered as a flood

wave from tributaries and, in turn, progress through the principal channel approximating a synthetic flood hydrograph. Hydrographs of flood flows should be prepared for all characteristic sub-areas, both with and without control measures. These flows should be routed in turn and progressively from the tributaries into the principal channel through the points on the watershed at which it is desired to determine the economic benefits. Wherever a flood detention or storage structure is located, the flood reduction benefit of such storage will be reflected in each succeeding hydrograph during the routing process. Thus the cumulative benefits in actual modification of flood flows will be demonstrated. This assembling and routing will offer a basis for evaluation of the control program in terms of reduction of flood crest as affected by delay in time of concentration and desynchronization of tributary flows. It is necessary also to consider the silt loading of the hydrographs, as this affects the regimen of the stream or conveyance channel. Future conditions of the regimen may be indicated through increases or decreases in channel storage and conveyance capacities. Ground water and base flows can be shown in the hydrograph presentation.

The degree of accuracy with which the hydrographs may be prepared will depend upon the ratio of constant and measurable data and records to approximate data in any given watershed, both of which, in turn and in part, may depend upon the accuracy of the surveys.

The carrying out of these planning procedures in a complete manner should enable the engineer, economist, and associated technicians to formulate an estimated schedule of sequence of construction and budgeted costs over the required period of years. This schedule may be used to balance the costs of the engineering and other features of the flood-control plan against the benefits to be derived. Conclusions may then be reached as to whether or not the over-all flood-control plan is technically feasible and socially warranted.

Farmers' Bulletin No. 1789, "Terracing for Soil and Water Conservation," has had a record distribution since its release last spring. A distribution of almost 100,000 copies in 7 months marks it as one of the most popular bulletins that has been issued by the Soil Conservation Service. It is a compilation of the best information now available on terrace construction and its coordination with other recommended soil-conservation practices. This bulletin should lead to a more efficient use of terracing and a better understanding of its place in a complete soil-conservation program

THE establish-
ment of ade-
quate erosion-control
practices throughout
the country is such
a tremendous under-
taking that it is im-
perative the work
be done as efficiently
as possible. This is

true regardless of whether the method involves a shifting of crops and the establishment of rotations, or the construction of protective structures such as terraces, dams, contour furrows, etc.

The demonstration projects have served not only as demonstrations of practices to the farmer, but they have also been a proving ground for the development of efficient ways and means of establishing the necessary practices. Unfortunately most of this experience has been gained with large equipment. There is still need for further development in accomplishing the same results with machinery ordinarily available to the farmer.

As more and more demonstration projects complete their programs, the type of work done by the Service is constantly changing. The field of activity is expanding rapidly as conservation districts are established, and as water-facilities and flood-control programs are set up. This changing picture involves a spreading of the activities over such large areas that the most effective utilization must be made of all available equipment, if the necessary work is to be completed within a reasonable time—this regardless of whether it is owned by the Federal Government, by States, counties, districts, private contractors, or farmers.

Even with the efficient utilization of all available equipment, more will often be required to carry out the additional work under the jurisdiction of the conservation districts as they are formed. Equipment needed by the districts may be acquired by loan from Federal or other agencies, by direct purchase by the districts, through cooperative purchase by the farmers of the district, or purchase by the county or other local government or by private contractors.

Regardless of how the equipment is acquired, it is necessary that it be carefully selected for adaptation to the work. Analysis of the job should be made with special consideration for the nature of work to be done throughout the year, amount of equipment shifting necessary and length of such moves, amount of work

EQUIPMENT PROBLEMS IN CONSERVATION WORK

By G. E. Ryerson and William X. Hull¹

to be done, the rate at which it is desirable to accomplish the work, peculiar soil conditions which preclude the use of some types of equipment, and the training and experience of the personnel who will operate the equipment.

Many farmers may find it cheaper and more satisfactory to do a large part of the construction work themselves. This should be encouraged especially if farmers can build terraces and construct dams more cheaply, because not only is the necessary cash outlay reduced to a minimum but the landowners develop greater personal interest in the structures and their proper maintenance.

In developing the work plans for the operation of any unit of heavy machinery, a sure and quick means of collecting must be developed. One possibility is to require the farmer to sign a note, prior to the accomplishment of the work, for an amount equal to the cost estimate for the job, collection to be made after completion of the work, either from the farmer or by discounting by a local bank. Another possibility is payment of the charges by the local government and collection through a tax on the land. This plan would require legislation in most States, but has the advantage of allowing the work to be paid for as it produces additional income for the landowner.

Even after satisfactory methods of financing the equipment are developed, it is necessary that the work be adequately planned and that the equipment be kept in operation as much of the time as possible. This may be done in communities where both terraces and dams are to be constructed, by shifting the work to terrace construction during that part of the year in which the land is free from crops, and to dam construction and other activities during the remainder of the year. Where the major portion of the work consists of terracing, it might prove advisable to develop a seasonal price scale, charging a higher rate while the land is free of crops and a reduced rate during the balance of the year. Furthermore, work should be scheduled throughout communities to avoid unnecessary moving about of heavy machinery.

¹ Agricultural engineers, section of engineering, Soil Conservation Service, Washington, D. C.

The equipment itself must be efficiently managed by well-trained and responsible operators who will operate it at its optimum efficiency without misusing or abusing it and who will provide it with adequate care and maintenance. This will require payment of good wages in order that trained operators are retained. In fact, it may be advisable to put these operators on a wage scale one and one-half or two times that prevalent in the community for similar work, but to allow no pay for layoffs, through breakdowns, thus encouraging proper care of machinery. Efficiency in the operation of equipment can be obtained only by some such system.

Tillage Machinery

All erosion-control measures are for the purpose of conserving the productiveness of the soil for future needs. The measures recommended oftentimes are objected to by the farmers because they fear interference with their farm operations. These fears may be either real or imaginary. Any erosion-control measure which changes or alters the farm operations may be a real hardship if the farmer is forced to develop a new technique in performing his normal operations. The recommended practices may also interfere with the operation of the farm equipment. This condition is recognized by most of the Service technicians in that the practices are often tempered by the equipment available on the farms. For instance, size of terraces varies considerably between the farms in the Piedmont Plateau and those in the Black Belt of Texas. This variation in size is due largely to the machinery commonly used in those sections. The width of strips may also be widened in communities where large and cumbersome units are commonly used. Changes from erosion-promoting to erosion-resisting crops and the development of rotations may not be possible, where suitable equipment for handling these new crops is not available on the individual farms or in the community.

The problem of providing suitable equipment to correct a deficiency on individual farms, or even within communities, is not particularly serious as farmers will procure equipment in one way or another if they are convinced that the measure requiring new machinery is economically sound. Of much greater importance is the fact that the farmers lack experience not only in operating the needed equipment but in performing farm operations in the manner necessary to control erosion.

Any limitations placed on the methods in which farmers may perform their normal operations must

necessarily reduce the efficiency of those operations unless new and more efficient means are devised. The endeavor to meet this problem has so far resulted in a modification of erosion measures so that farm operations are interfered with as little as possible. In many instances, there is some sacrifice of erosion protection in this effort to prevent too much interference with the farm work.

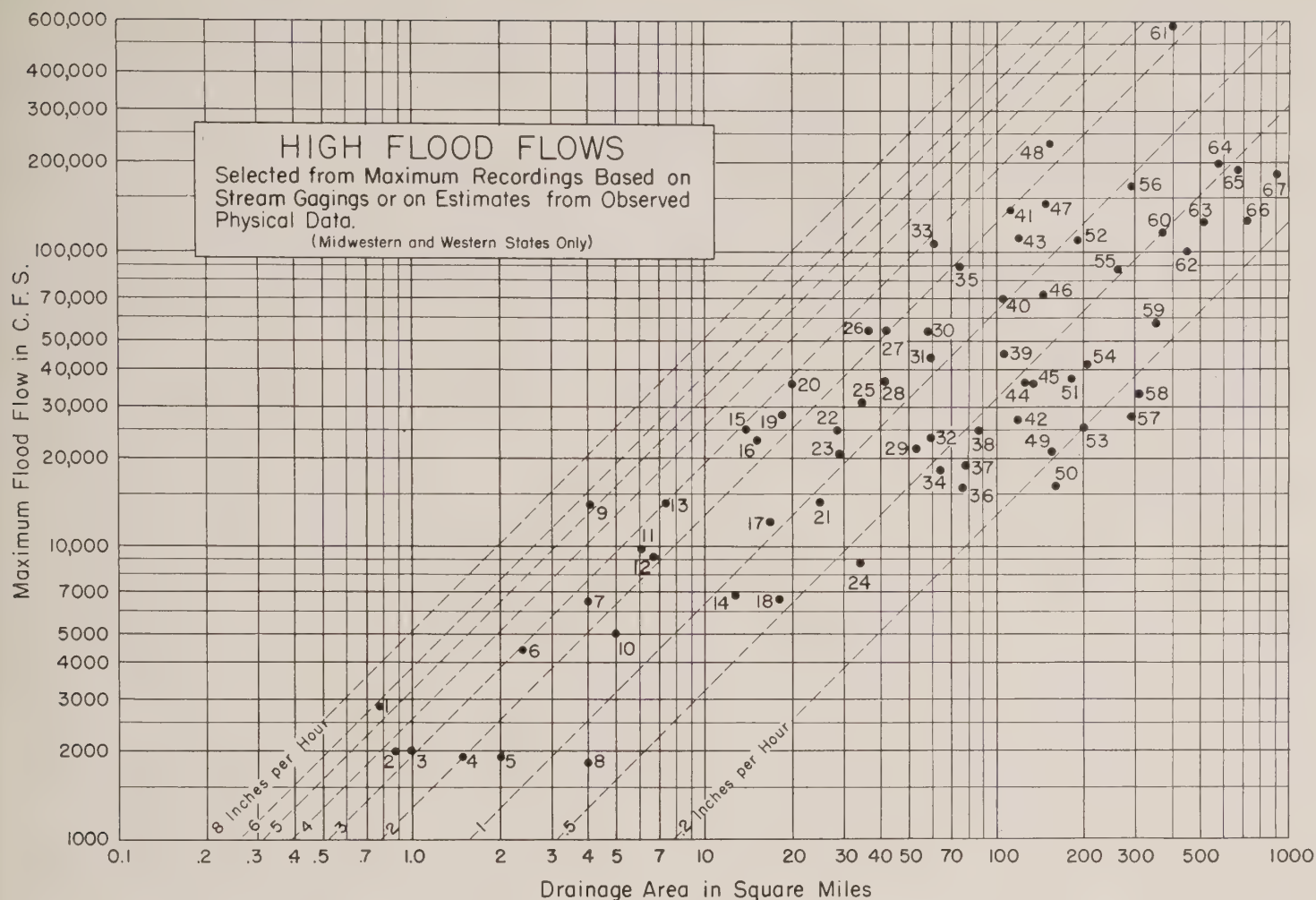
So far as is known, no consideration has been given to the mechanical movement of soil by the tillage implements. Any tillage implement, when operated either down the slope or across it, will move more soil down the slope than up. This, in effect, is the same as erosion. A moldboard plow will not only throw more soil down the slope than it will up, but will throw it farther. A disk harrow also causes considerable movement of soil down the slope. These contour operations, when coupled with erosion, tend to produce a benching effect.

The only method, thus far attempted, of preventing benching is to so regulate the placement of lands that the downward movement of soil is uniform. The value of special implements such as two-way plows and disks has not been fully explored. It is possible, for instance, that the use of a two-way plow would nullify much of the soil movement caused by erosion. It is also possible that terraces could be reshaped to almost any desired cross section within a few years at practically no expense, since it would involve merely the controlling of a normal operation. This would permit the elimination of most of the difficulties encountered in operating other implements on terraced land.

In the production of row crops under a system of contour farming four methods of row placement are advocated by various technicians. These are (1) placement of the ends of point-rows in the terrace channel, (2) at the base of the terrace ridge, (3) at the center of the terrace interval, and (4) elimination of point rows by placing the irregular areas in the strip devoted to the production of a close-growing crop.

No study has been made to determine the cost of turning at the ends of the extra rows which must be done when contour farming is practiced. There is therefore no way of telling which of these methods is most practical. No data are available concerning crop destruction in the turn areas, that caused by side-slippage of the cultivator, crop losses caused by poor control of weeds due to side-slippage of the cultivator, or of losses resulting from uneven depth of planting over the terrace ridge.

(Continued on p. 184)



Key No.	Stream and location	Discharge per sq. mi. in c. f. s.	Year
1 ^L	Pasadena Glen, at Falls, Calif.	3,589	1938
2 ^L	Rubio Canyon, at Rubio Falls, Calif.	2,273	1938
3	Skyrocket Creek, Ouray, Colo.	2,000	1923
4	Maggie Gulch, near Golden, Colo.	1,270	1923
5	Cherryvale Creek, at Cherryvale, Kans.	930	1923
6	Missouri Canyon, at Mouth, Colo.	1,810	1923
7 ^J	East Hay Creek (Washita Basin), Okla.	1,590	1934
8	North Canyon, Centerville, Utah	450	1923
9 ^G	Bunton Branch, near Kyle, Tex.	3,370	1936
10	Hull's Gulch, Boise, Idaho	1,000	1913
11	Hogan's Gulch, Eden, Colo.	1,580	1904
12	Blue Ribbon, Pueblo, Colo.	1,360	1921
13	Cameron Arroya, near Pueblo, Colo.	1,900	1921
14	Sand Coulee, near DuBoise, Wyo.	515	1934
15 ^G	Dry Creek, near San Angelo, Tex.	1,760	1936
16 ^L	Devil's Canyon, above San Gabriel Dam #2, Calif.	1,493	1938
17 ^J	San Antonio Creek, near Claremont, Calif.	710	1938
18	Little Red Creek, Circle, Wyo.	358	1934
19 ^G	Alazon Creek, San Antonio, Tex.	1,497	1921
20	Willow Creek, near Heppner, Oreg.	1,800	1903
21	Pinal Creek, near Globe, Ariz.	560	1904
22	Burro Canyon, Madrid, Colo.	852	1925
23 ^J	Tehachapi Creek near Tehachapi, Calif.	704	1932
24	Crow Creek, near Cheyenne, Wyo.	251	1924
25 ^H	Granada Creek, above Granada, Colo.	886	1935
26 ^J	Sergeant Major Creek, Okla.	1,450	1934
27 ^J	East Quartermaster Creek, Okla.	1,320	1934
28 ^J	Nine Mile Creek, Okla.	860	1934
29	Ysabel at Grande, Calif.	395	1916
30	Rock Creek, near Pueblo, Colo.	913	1921
31	Kiowa Creek, at Elbert, Colo.	725	1935
32 ^J	North Fork of Skokomish, Hoodport, Wash.	389	1933
33 ^A	East Fork of James, Old Knoxville, Tex.	1,730	1932
34	Wynoochie, Oxbow, Wash.	277	1935
35 ^G	East Fork of Frio River, near Leaky, Tex.	1,190	1932
36	Bull Run at Reservoir, Oreg.	203.9	1931
37	Soleduck at Fairholm, Wash.	238.5	1917
38	Sultan, at Sultan, Wash.	279.5	1921
39	San Jacinto River, San Jacinto, Calif.	417	1927
40 ^J	West Quartermaster Creek, Okla.	640	1934
41 ^G	Johnson Creek, near Ingram, Tex.	1,240	1932

Key No.	Stream and location	Discharge per sq. mi. in c. f. s.	Year
42	South Fork of Stilaquonish, Granite Falls, Wash.	223	1932
43 ^H	Kiowa Creek, above Kiowa, Colo.	917	1935
44	Willow Creek, Morgan, Oreg.	288	1903
45	Siletz, near Logsdon, Oreg.	270.7	1921
46 ^H	Mouth of Bijou, by mouth of Wilson Creek, Colo.	488	1935
47 ^G	Salado Creek, Salado, Tex.	965	1921
48 ^G	Seco Creek, 7 miles above D'Hanes, Tex.	1,500	1935
49 ^A	Custer Creek, northeast, Miles City, Mont.	135	1938
50	Turquoise Creek, Mora Valley, N. Mex.	100	1904
51	Baker, near Concrete, Wash.	200	1917
52 ^H	Kiowa Creek, north of Kiowa, Colo.	578	1935
53	Cove Creek, at Phoenix, Ariz.	125	1904
54	Siletz, at Siletz, Oreg.	200	1921
55	Bear River, near Van Trent, Calif.	336	1907
56 ^J	West Bijou Creek, Byers, Colo.	580	1935
57	Mora River, at Weber, N. Mex.	94	1904
58 ^A	Beaver Creek, Wibaux, Mont.	106	1933
59	Skykomish River, near Index, Wash.	160	1917
60 ^G	Tenaha Creek, near Joaquin, Tex.	313	1933
61 ^C	West Fork Nueces River, near Brackettville, Tex.	1,440	1935
62	Queets, near Clearwater, Wash.	220	1935
63 ^J	San Luis Rey, Bonsall, Calif.	250	1935
64 ^G	Guadalupe River, Kerrville, Tex.	344	1932
65 ^H	Jim Ned Creek, near Brownwood, Tex.	280	1932
66	Lewis River, near Ariel, Wash.	176	1933
67 ^G	Guadalupe River, near Comfort, Tex.	19.9	1932

L—Los Angeles County Flood District Report; March 2, 1938.
J—"Maximum Stream-Flow with Reference to Flood Formulas," by C. S. Jarvis, Transactions American Geophysical Union, 1937.
G—"Major Texas Floods of 1936"; Geological Survey Water-Supply Paper #816.
H—"Rainfall and Run-off in Colorado," by M. C. Hinderlider; Engineering News Record, August 13, 1936.
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BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



FLUID MECHANICS FOR HYDRAULIC ENGINEERS. By Dr. Hunter Rouse. New York and London. 1938.

In this, his new book, Dr. Rouse gives a clear presentation of the development of fluid mechanics, and shows the application of the modern theories and data to practical problems; it is apparent that he seeks thereby to convince the hydraulic engineer that there is much to be gained by giving heed to rational methods of analysis and research.

Dr. Rouse has been a member of the staff of the Soil Conservation Service cooperative hydraulic laboratory at the California Institute of Technology, Pasadena, Calif., almost since its inception in 1935. At the time this book was published he held the grade of assistant soil conservationist in the section of sedimentation studies, but since that time he has been promoted to the grade of associate hydraulic engineer. Although Dr. Rouse has spent much of his time on the study of theories of suspension and transportation of sediment as related to flood turbulence, he has taken an active part in the planning and operation of many other studies that are being made at the laboratory.

For about 30 years there has been a trend to bring together the theoretical or mathematical hydrodynamics and the so-called hydraulics which was based almost entirely on experiments. During the development of theoretical hydrodynamics in the second half of the last century, contact with reality and with practical engineering problems receded more and more into the background. This was due to the fact that in this so-called classical hydrodynamics everything was sacrificed to logical construction, and results could not be obtained unless deduced from the basic equations. Yet, in order to overcome the mathematical difficulties, these equations were simplified in a manner which often was not permissible even as an approximation.

On the other hand, the hydraulics which tried to answer the multitudinous problems of practice became gradually disintegrated into a collection of unrelated problems. Each individual question was solved by assuming a formula containing some undetermined coefficient and then determining these by experiments. Each problem was treated as a separate case, and there was lacking an underlying theory by which the various problems could be correlated.

The rapid development of aeronautics, and the application of aerodynamic principles to hydraulics and other branches of fluid mechanics, are mainly the results of pioneer work during the last fifteen years by Prandtl, Nikuradse, and Von Karman. These recent studies, which are based on mathematical hydromechanics, have been presented in several recent books on fluid mechanics.

Although the subject matter of Dr. Rouse's volume is of an advanced nature which is perhaps beyond the grasp of the reader lacking a foundation in elementary hydraulics, the book will be of considerable value in bed-load studies as carried on by the sedimentation and river hydraulic investigations section of the Soil Conservation Service.

As an introduction to his text the author briefly discusses dimensional analysis, the powerful mathematical tool of research. The remainder of the book is divided into three parts. Part I deals with the fundamentals of hydromechanics and it is here that the elementary principles and generalized equations of flow are dis-

cussed. Irrotational motion and conformal mapping—both valuable aids in solving complex flow problems—are presented in two separate chapters and with considerable thoroughness. This is a great advantage to Dr. Rouse's readers, as these subjects are not treated completely in contemporary books.

Part II contains material which is perhaps of more interest to the practicing engineer. The modern conceptions of fluid turbulence are treated in great detail and illustrated by experimental data. The problems of open-channel flow are uniquely treated and illustrated with experimental data much of which was observed by the author. The problem of transportation of sediment, which is of great importance in soil conservation studies, is also discussed.

Part III deals with the problems of the mechanics of wave motion, and here again is an important subject which is more completely treated than in contemporary books.

A few of the physical properties of water and some other common fluids are given in the Appendix.

EQUIPMENT PROBLEMS

(Continued from p. 182)

Fear of farmers as to difficulties in operating implements for erosion-control practices, and the inconvenience of changing farming systems are probably the greatest deterrents to a widespread adoption of the measures. These fears can be dispelled only by proving that the necessary practices do not work a hardship and by showing how to minimize the inconvenience caused by changing the farming system.

Undoubtedly there are many opportunities to increase the erosion-control value of the tillage practices by modifying them, or by developing new ones which can be more easily carried out by the farmers than those now commonly used, perhaps to the extent that there will be an actual decrease in the cost of performing the farm operations.

The development of more efficient methods through modification of the tillage practices can be accomplished only by an organized study of the problems. Such a study would serve not only as a means of developing more efficient technique in the use of present equipment, but would also be a means of determining which of the available types are most suited to operation under the varying conditions. Minor modifications which would make the various units more suitable to specific uses would also be developed. Any deficiencies in existing types would be brought to light, and this would permit manufacturers to make necessary adjustments in future models and to develop new equipment, whenever an economically justified need exists.

Recent Bulletins Discuss A Wide Range of Farm Topics

For **REFERENCE**
Compiled
by Mrs. ETTA G. ROGERS, Publications Unit

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Office of Information U. S. Department of Agriculture

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ENGINEERING

TERRACE OUTLET CHANNEL

STOCK POND

TERRACES

ROADSIDE CONTROL

STRUCTURES GULLY CONTROL

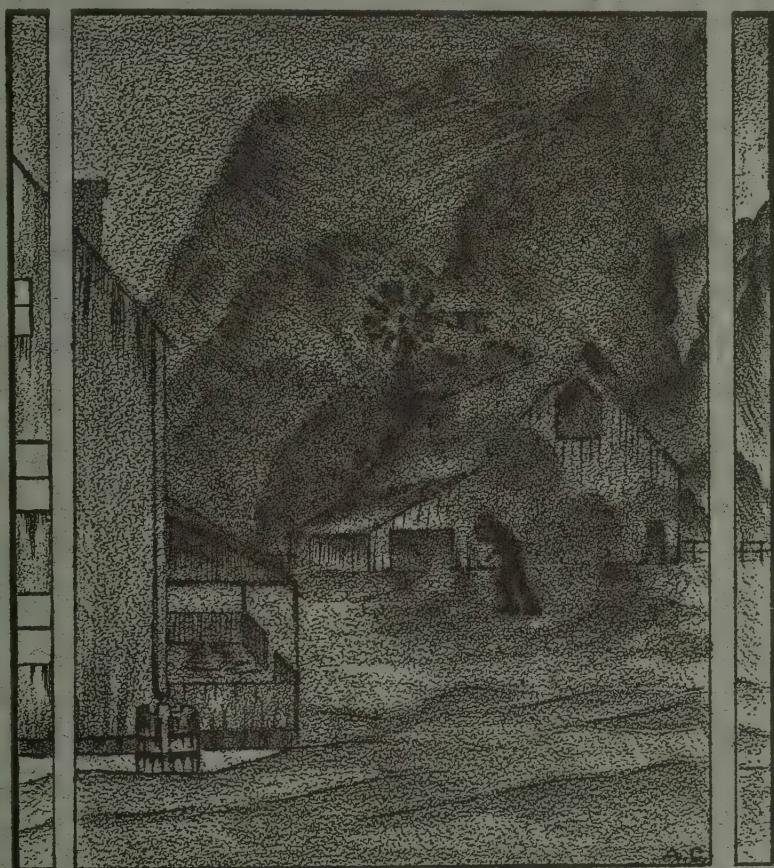
CONTOUR FURROWS

FARM PLAN

CONSTRUCTED
EROSION CONTROL
MEASURES ARE
OFTEN NECESSARY
TO PROVIDE A
COMPLETE FARM
CONSERVATION
PLAN

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



February 1939

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WELLINGTON BRINK
EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

VOL. IV • NO. 8



H. H. BENNETT
Chief, Soil Conservation Service

FEBRUARY • 1939

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

The SOIL CONSERVATION APPROACH TO

PROPER LAND USE

BY C. B. MANIFOLD¹

ON 165 demonstration projects, more than 350 C. C. C. camp areas, and 4 public-land watershed projects, the Soil Conservation Service has brought about a 14-percent decrease in land under cultivation and a 29-percent decrease in rate of stocking ranges. At the same time, it has pointed the way toward an ultimate correction of many land abuses.

The first work of the Service was to demonstrate how changes in land use and mechanical practices, with better use of vegetation, can effect a reduction in accelerated erosion. More than 60,000 farmers in private land project and camp areas are cooperating with the Service in the endeavor to conserve moisture, control erosion, and make proper use of each acre of land. Surveys of soil conditions, of erosion, and of farm organizations have been made on each farm under cooperative agreement—this to assure that the changes indicated and installed would put the farm in condition for maintaining and improving its productivity on a permanent basis. In making changes in land use, full account is taken of the needs of the livestock which should be kept on the farm.

¹ Chief, division of conservation operations, Soil Conservation Service, Washington, D. C.

Land uses in practice on 11,402,452 acres at the time the cooperative agreements between the farmers and the Service were signed, and the changes necessary to bring about proper land use are indicated in tabular form below.

These data are also shown graphically in the illustration.

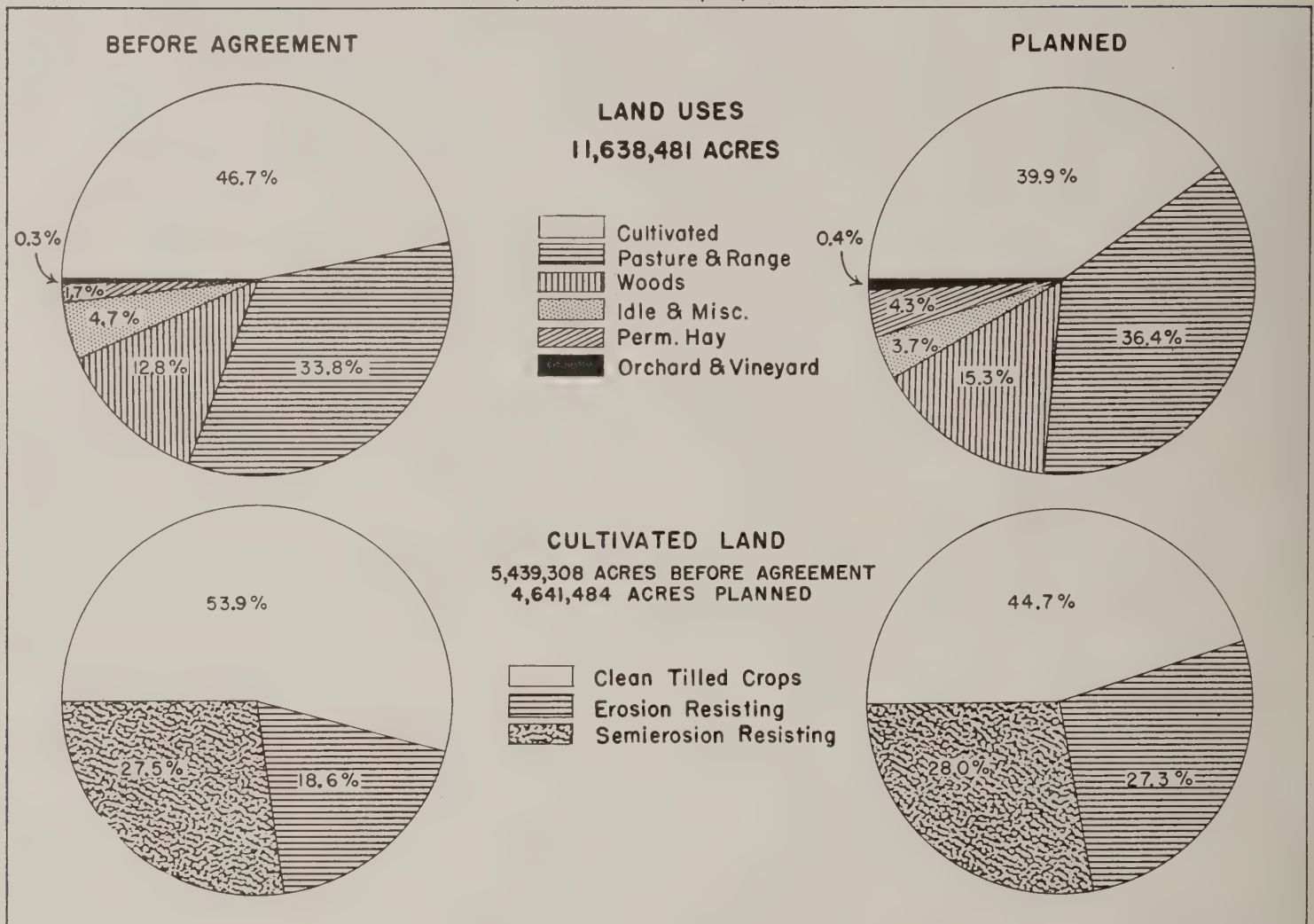
Land-use changes

Land use	Before agreement	After planning	Changes in acreage
	<i>Acres</i>	<i>Acres</i>	<i>Percent</i>
Cultivated.....	5, 439, 308	4, 641, 484	14.7 decrease.
Orchard and vineyard....	38, 176	39, 280	2.9 increase.
Permanent hay.....	202, 701	501, 723	147.5 increase.
Pasture and range.....	3, 931, 208	4, 238, 354	7.8 increase.
Woodland.....	1, 484, 048	1, 785, 752	20.3 increase.
Idle, miscellaneous.....	543, 040	431, 888	20.5 decrease.
Total (under agreement).	11, 638, 481	11, 638, 481	

The program of the Service provides for taking out of cultivation all severely eroded and gullied land and steep slopes subject to such erosion, and the planting of this land to a permanent cover of grass or woody vegetation. Of the 5,439,308 acres in cultivation when the agreements were signed, provision was made for converting 903,325 acres, approximately 16.6 percent, to other uses shown in tabular form on the next page.



SUMMARY OF LAND USES BEFORE AND AFTER PLANNING
(CUMULATIVE SEPT. 30, 1938)



	Acres
To orchards and vineyards	1, 862
To permanent hay	305, 302
To permanent pasture	452, 226
To woodland	135, 964
To other uses	7, 971

Incidentally, as certain areas of pasture, woods, hay, and idle land were found suitable for cultivation and appeared to be needed for this purpose these areas were converted to cultivated crop production; approximately 105,501 acres have been so converted. The soil conservation program therefore involves a net reduction of approximately 14.7 percent in the land under cultivation. This is only an average figure and cannot safely be applied to each farm as operations are carried out in this Service. A considerably larger reduction should be made to effect ideal land use. In many instances, especially on small farms without sufficient cropland to maintain an acceptable standard of living, it is not practicable to effect such a large percentage reduction in the acreage of cash crops.

On the other hand there are many instances, as in the case of the large wheat farms of the Palouse coun-

try of the Northwest, where reductions of 25 percent or more in cultivated acreage were feasible. It was found that 25 percent of this acreage in the Palouse country consisting of the clay hilltops and the steepest and most erodible slopes, was producing only 15 percent of the crop at about 35 percent of the total cost. Obviously a big measure of erosion control and also more profitable crop production were effected where such land was retired to a perennial cover of alfalfa and grass.

A total of 204,805 acres, or approximately 6 percent of the pasture acreage as of the time of signing agreements, were unfit for continued use for grazing, and plans have been made for converting such land to woodlands. This, together with other conversions, resulted in an increase of approximately 20.3 percent in woodland acreages, most of the increases being accounted for through the development of small wood lots on nearly every cooperating farm. While these woodland areas have been planned for the production of lumber, posts, fuel, and as windbreaks, their use for wildlife protection also has been given consideration.



Planting to trees in 1935, with protection from grazing during the following 3 years, has converted this nearly worthless pasture in Muskingum County, Ohio, from an extreme erosion hazard to a haven for soil, water, and wildlife.



On quite a number of farms special areas have been set aside for wildlife. These areas are usually odd corners in fields, gullies, borders along fences or woodlands, etc. While in most cases these areas are too small to be accounted for in the tabulation of land-use changes, they are so distributed as to make the whole farm available to wildlife. Besides these small areas approximately 13,260 acres have been planned for

wildlife use, thus ensuring a valuable contribution to wildlife in addition to adequate erosion control.

Along with the adjustments in land use, the cooperative agreements provide for certain improved land-management practices. Cultivated lands representing approximately 46.7 percent of the total acreage, and subject to the severest erosion, naturally have been given the greatest consideration. Provision has been



Protection from grazing for 6 years has killed out the snakeweed, restored a vigorous stand of grass in Dona Ana County, N. Mex. Similar results are obtained by stocking at the correct carrying capacity.

made for contour tillage, strip cropping, cover crops, soil amendments, and in a great many cases, terracing in combination with any one or a number of these practices. Definite crop rotations have been developed which provide a balance between feed, cash, and hay crops and at the same time reduce to as great a degree as possible the acreage in crops requiring clean cultivation. A definite trend is shown in the program pointing to a reduction of some 859,447 acres, approximately 29.8 percent, in clean-tilled crop acreage. This reduced acreage was offset through the increase of crops that are partially erosion-resistant, such as small grains and annual hay crops, and erosion-resistant crops such as perennial hay crops. The increase in the hay production program serves to ensure against the overgrazing of permanent pastures early in the spring, late in the fall, and during periods of drought.

The grazing of pastures and range lands according to the carrying capacity of the perennial vegetation is a fundamental concept in the program of the Service, and is most effective in maintaining the productivity of the soil and providing nutritious forage. In the case of all forage grasses there is a most favorable method of grazing, which provides forage to be used during the immediate season, ensures perpetuation of the stand and future production, and protects the soil from acceler-

ated erosion. Grazing which allows too little top growth limits root growth, and in turn limited root growth checks top growth. The result of such grazing is that forage for the season is less abundant than it should be, and the storage of an adequate plant food reserve in the roots to start vigorous growth the following spring is prevented.

On private land areas in the humid sections, where there has been increased production of erosion-resistant and semi erosion-resistant forage crops, practically no reduction in stock has been necessary. Such increased production is largely the result of better crop rotations including more legumes, soil amendments such as lime, manure and commercial fertilizers, water conservation practices, and reduced losses of surface soil.

In the four western watershed areas which include approximately 90 percent of public and Indian-owned lands, it has been necessary to plan for adjustment of stock to the carrying capacity of the range. On 6,010,880 acres, where range-management plans have been put into effect, there has been a reduction from 142,016 to 100,538 animal units, or 29 percent. Similar reductions in the rate of stocking have been made on privately owned range land in other Service work areas in the West. On these areas sufficient practicable pos-



A desirable distribution of close-growing and clean-tilled crops, woodland and pastures in South Carolina. Contour strip cropping, contour orchard planting, and terracing are helping to effect soil conservation and flood control.

sibilities do not exist for increasing the grazing area and/or increasing the production of supplemental feed. Hence, a reduction in numbers is the only method applicable to restore the stand and vigor of those grasses which provide the best feed and the best protection for the soil. Reductions in numbers of livestock are more than offset by smaller death losses, larger calf and lamb crops, greater weights at weaning time, and better prices per hundred weight.

A program designed to change an exploitative or speculative type of agriculture to one of stability and permanence must take into account all factors relating to the use of the land. It must involve in particular the physical features of the soil, including the degree and rate of erosion for each field and parcel of land. It must include careful studies of the capabilities of each field and parcel of land for the production without accelerated erosion of cultivated crops, pasture, permanent hay, woodland, and wildlife. The best species and strains of plants must be determined, not only from the standpoint of production but from the standpoints of persistence, and erosion-control and soil-building values. The safest and most effective practices relat-

ing to water conservation are of utmost importance; and proper fertilization, tillage, harvesting, handling of crop residues, grazing, and mechanical measures for the control of run-off must be put into operation on a permanent basis. Extremely important also is close consideration of the economic and social statuses and needs of farmers and operators.

A definite crop rotation, followed from year to year with ample provision for soil-conserving and soil-building crops, goes a long way toward stabilizing crop production and avoiding huge surpluses of cash crops which result from speculative plantings. A farmer who agrees to follow such a crop rotation and who produces a large part of his food, including livestock products, on his own farm is in a much better economic position during years of superabundant crops resulting from unusually favorable climatic conditions.

Wildlife in its relation to soil conservation and better land use will be the theme of a special issue of SOIL CONSERVATION next month.

MEASURING THE EFFECT OF LAND USE ON EROSION

By H. L. Thomas, I. J. Nygard, and L. E. Bullard¹

THE primary purpose of a detailed soil conservation survey is to obtain specific information for use in planning an erosion-control program for an individual farm. However, it can be made to serve another purpose—that is, to provide general information that will be of value in future planning.

Technicians on the Beaver Creek erosion-control demonstration area in southeastern Minnesota have developed a practical method of obtaining and analyzing this information as it applies to the effect of land use on erosion. The method and results are reported in this paper with the idea that it may be used effectively on other areas. This system should be especially applicable on small watersheds.

In making the survey the surveyor starts at a given point on the farm which he is studying, walks over each field and, with a soil auger, examines the soil and determines the extent of erosion at frequent intervals. He also observes the slope of the land and notes the use made of the land. This information is recorded on an aerial photograph used as a base map. A complete map shows as accurately as possible the soil type boundaries, cover or land use, slopes, and different degrees of erosion. Standard symbols are used on the erosion survey map to denote the various classifications of slope, extent of erosion, soil type, and land use.

To determine the average depth of the A horizon of every soil type a careful examination must first be made of the soil profiles of virgin areas. The degree of erosion is then ascertained by estimating the number of inches of topsoil (A horizon) that has been removed from a given field or area as compared with the virgin soil under similar topographic conditions.

Next comes an analysis of the information recorded on the survey maps. The first step used in securing the results presented in this paper was to list on separate cards the complete symbols for all areas that had been worked out on the map. For example, one card was made for the area $\frac{16-L}{BB-3}$, one for $\frac{16-L}{A-2}$, etc.

This listing was completed for all the land surveyed, making a total of 5,304 cards, each representing one separately classified parcel of land, or in other words,

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one set of observations. No attempt was made to obtain the area of these parcels of land.

The second operation was a classification of the cards. They were separated and arranged in groups representing the cultivated, open-pasture, and forest sites. Each site group was then divided into the five slope groups, and the final assortment consisted of a classification of each slope group into five erosion classes. Totaling the number of cards in each of these final groups, the frequency of occurrence was obtained for each class of sheet erosion under any given set of conditions. From these data it was possible, for example, to determine the percentage of cases of 4 erosion on BB-slope cultivated land, and to compare it with the percentage of cases of 4 erosion on BB-slope forest land.

One final calculation was performed in order to arrive at the data presented in this article. The average number of inches of topsoil lost on A-slope cultivated land was calculated, also that on B-slope cultivated land, and so on through the whole list of groups. These figures were obtained by multiplying the middle value of each erosion class by the frequency or number of observations and dividing by the total number of observations. The middle value for erosion class 1 was obtained by multiplying by one the typical virgin depth in inches of the soil type involved, for erosion class 2 by multiplying the virgin depth by 12.5 percent, for erosion class 3 by multiplying the virgin depth by 42.5 percent.

The following example of a calculation will help to make clear the method used in estimating the inches of topsoil lost on the basis of the classified observations which were drawn from the survey maps:

Erosion class	Column I Number of observations placed in each erosion class in the case of cultivated Tama silt loam on B (3-7 percent) slope	Column II Factor obtained by multiplying the middle value of each erosion class by 12 inches or the typical virgin depth of Tama silt loam. This figure represents the inches of topsoil removed	Column I multiplied by column II
1.....	21	0.0	0.0
2.....	213	1.5	319.5
3.....	8	5.1	40.8
4.....	0	8.4	0.0
Total.....	242		360.3
Average number inches topsoil lost on cultivated Tama B slope (found by dividing 360.3 by 242).....			1.49 in.

The effect of land use on erosion in Beaver Creek watershed

Slopes	Average amount of topsoil lost from—			Number of observations recorded on—		
	Cultivated land	Pasture	Forest	Cultivated land	Pasture	Forest
	Inches	Inches	Inches			
A (0 to 3 percent).....	0.06	0.07	0.00	216	42	16
B (3 to 7 percent).....	1.87	.58	.15	675	149	82
BB (7 to 15 percent).....	4.14	.90	.07	1,528	362	285
C (15 to 25 percent).....	4.52	1.25	.04	834	410	339
D (above 25 percent).....	4.69	.98	.06	61	112	193
Average ¹ or total.....	3.51	.96	.07	3,314	1,075	915

¹ The averages were obtained by totaling inches of soil lost in each observation and dividing by the total number of observations.

One distinct advantage of this method of studying the erosion problem is that it deals with conditions as they steadily exist in the field. Someone may raise the criticism that it is not possible to measure the inches of topsoil lost over a large area nearly as accurately as the data would indicate has been done by the investigators. It must be realized, however, that, strictly speaking, any quantitative measurement is no more than an estimate; and the writers believe that by estimating soil loss a great number of times and as accurately as possible, and then taking the average, an accurate appraisal can be approached. It should be noted that the losses are progressively greater as the slopes become steeper and also as the natural state of the land is more disturbed. This is the result that can be expected, and is an indication that the data give an accurate picture of the true situation as it exists in the field.

On cultivated land an average of 3.51 inches of soil has been removed, while in open pastures only 0.96 inch is gone, and in forested land practically none. The gullied areas were also much more frequent in the cultivated fields. Gullies were found on 17.6 percent of the cultivated sites and on only 4.6 percent of the open pasture sites.

The low figure, 0.06 inch for cultivated fields on A slopes, may need an explanation. On 207 of the 216 observations on these relatively smooth and level fields no measurable erosion was recorded. That is, no definite soil loss was noticed in measuring the depth of the A horizon on these 207 fields and comparing them with the depth of the A horizon on virgin or nearly virgin fields. Averaging these observations recorded as "no soil loss" with the nine showing definite soil loss gives this low figure. The writers are aware that accelerated erosion takes place on these relatively level fields, but were not able to record the small loss. The same explanation applies to the low figures presented for losses under forest cover.

In addition to the information relative to the effect of land use, the table clearly shows the effect of slope of

the land on sheet erosion. On the cultivated land in particular the losses are progressively greater on the steeper slopes.

A question may be raised as to why, on cultivated land, there has not been a much greater soil loss on D slopes than on C slopes, and on both C and D slopes as compared with BB slopes. The old settlers in the watershed relate that, in general, the land on the lesser slopes was the first to be broken from its virgin state on all farms. As more land was needed, steeper land was farmed. Possibly this situation will explain the fact that the losses on the most severe slopes have not been so great as one might expect. The same explanation will probably hold regarding the pastured land, since the steeper areas afford poorer grazing and would be used only after no other land was available.

Deferred Spring Grazing

Deferred spring grazing, often spoken of as range or vegetative readiness, signifies complete protection of pastures from grazing until the growth and development of the foliage has made a good start. After the dormant season herbaceous vegetation makes all new growth from the food stored in the roots. If this food supply is to be available each year the plant must be maintained in a vigorous and healthy condition. This condition is influenced by the number of days of full protection from grazing given to the range after growth starts. Sufficient time should be allowed for the desirable perennial species to produce enough foliage to provide a food supply for the current growth when being grazed. If healthy plants are protected from all grazing for from 10 days to 2 weeks after growth starts, the leaf production can usually keep ahead of the rate of cropping, provided the range is properly stocked.

Every acre of the grazing area should be so treated each and every year. This is a fundamental range-management practice that is necessary for soil and water conservation, range improvement, and maintenance.—*Liter E. Spence.*

Depth of Moisture and Yield of Wheat

By R. R. Hinde¹

RECOGNIZING that moisture is a limiting factor in wheat production in the Southern Great Plains, the Soil Conservation Service technicians in the project and camp areas are assisting farmers in their crop planning by taking soil samples to determine the depth and amount of moisture accumulations in the soil.

The average rainfall in the Southern Plains is approximately 18 inches but the variance during individual years is wide. As a whole, the area is highly favored in the distribution of annual rainfall, approximately two-thirds of the moisture coming from April to September, through the summer growing season. Moisture available during this growing period points to but one conclusion—that greater crop utilization can be made of the moisture that falls than has been done in the past.

In the Great Plains, where crop production is carried on under low annual rainfall conditions, the loss by run-off and evaporation of 9.3 inches of this moisture is a serious handicap in the production of a wheat crop. Only that retained in the soil and saved from loss by run-off and evaporation is available for plant use. Contour farming operations, supported by terraces and tillage practices that will increase the absorptive capacity of the soil and thus reduce the run-off and evaporation, are valuable in retaining moisture that otherwise might be lost.

Late plowing, listing, and one-waying are unsatisfactory methods of preparing a seedbed for wheat. These methods permit large losses of moisture through weed growth after harvest; also, a poor seedbed is usually the result of such practices. The seedbed which is prepared late is often dry, loose, and in poor tilth. Early listing, followed by a ridge-buster and a duck-foot cultivator later, has proved satisfactory from the standpoint of moisture conservation and good seedbed preparation.

The difficulty in producing wheat in the Great Plains is that the wheat farmer must prepare his seedbed and do his planting at least 9 months in advance of harvest. During this time rains may come, or they may not, resulting either in a profitable crop or loss of a crop. For this reason, wheat farmers continue to seed wheat in the fall and take a chance on making or

losing a crop. A flexible cropping system, which takes into consideration the soil moisture and fertility conditions of the field at each planting time, should be used where wheat is grown. Where this plan is used, a crop should be planted only when the moisture and residues are favorable—this in order that some assurance may be had of a profitable production and a vegetative cover for the land. It has been definitely determined by experiment stations in the Great Plains that the best land use and the highest economical returns can be secured by normal planting with favorable subsoil moisture conditions at planting time. In the case of wheat planting, 24 inches of moisture depth at seeding time is considered a safe margin. When moisture and residues are lacking, wheat should not be planted, or at least the acreage should be materially reduced. Soils of the Great Plains, where moisture is the limiting factor in crop production, are usually high in plant food content and have lost very little fertility due to leaching and removal by crops. The fertility, as a rule remains relatively constant and does not require regular cropping rotations, addition of commercial fertilizers, or the growing of legumes to restore nitrogen. Nitrogen is largely supplied in the western soils by the action of nitrogen-fixing bacteria living in the soils on decayed organic matter. The returning of crop stubble and residue to the soil, to replenish the organic content, is important in western agriculture.

As a result of studies made over a long period of time, A. L. Halsted and O. R. Mathews of the Division of Dry Land Agriculture in the Department have devised a method whereby the wheat farmer can forecast, fairly accurately, his chances of producing a profitable wheat crop. These two men discovered that the moisture already in the soil at planting time is a reasonably accurate index to the next year's harvest, and that the rains coming between seeding time and harvest time have little effect upon the yields of wheat.

These results and fact-finding data, which Halsted and Mathews compiled at the various dry land experiment stations, are something that the wheat farmer may use on his own farm in order to determine his chances of a profitable crop. By the simple use of a posthole digger, tile spade, or soil auger, the

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Harvesting Wheat with Combine, on Contour, Followed by One-way Disk Plow, Cutting and Mixing Stubble with Surface Soil. Conservation of Crop Residues is an Effective Wind-erosion Control. Immediate Disking of Stubble After Harvest Saves Moisture for the Next Crop.

depth of moisture in the soil may be determined. If the depth is less than 24 inches, a favorable wheat crop is uncertain.

If this practice is used by the wheat farmers every year there will be fewer wheat failures, and also an expansion of other crops planted as substitutes for wheat.

By the use of such soil-moisture tests the farmer may be able to decide early in the spring whether or not the wheat crop planted in the fall should be abandoned or left on the land for harvest. In the case of abandonment, the land may be prepared for another crop; or it may be summer fallowed early enough to prepare a good seedbed and conserve the early spring rains.

Probabilities of obtaining specified yields of wheat in soil dry or wet to designated depths at seeding time, as determined by the Division of Dry Land Agriculture, U. S. Department of Agriculture, Hays, Colby, and Garden City, Kans.

Depth of moisture at seeding time	Percentage of chances of obtaining specified yields				
	Failure	5 to 10 bushels	10 to 20 bushels	20 to 30 bushels	30 or more
Soil dry.....	71	11	18	0	0
Wet 1 foot.....	34	23	24	19	0
Wet 2 feet.....	34	23	24	19	0
Wet 3 feet.....	10	6	14	47	23

Observations of 84 wheat crops from 1924 to 1937, made by H. H. Finnell at the Panhandle Agricultural

Experiment Station, Goodwell, Okla., showed that a forecast of wheat yields could be approximated by considering four factors previous to or at the time of seeding. These factors are (1) July rainfall, (2) soil moisture depth in the fall, (3) amount of available nitrogen in the soil, and (4) the amount of unrotted vegetable matter in the soil.

Where all 4 factors were favorable, 6 crops produced 30 bushels; where 3 factors were favorable 16 crops produced 20.5 bushels; where 2 factors were favorable 23 crops yielded 9.5 bushels; where 1 factor was favorable 34 crops yielded only 1.25 bushels, and where no factors were favorable 5 crops yielded one-third bushel. A summary in tabular form of field tests made at Clovis, N. Mex., Vega, Tex., Liberal, Kans., Hereford, Tex., and Perryton, Tex., is presented below. The table shows percentage of fields falling in each soil-moisture depth classification.

Yields (bushels per acre)	Soil-moisture depth				
	0 to 6 inches	6 to 12 inches	12 to 24 inches	24 to 36 inches	36 to 42 inches
	Percent of fields	Percent of fields	Percent of fields	Percent of fields	Percent of fields
Failure.....	18	36	50	31	.....
1 to 5.....	13	8	10	14	10
6 to 10.....	41	24	12	17	10
11 to 15.....	19	13	17	22	30
16 to 20.....	9	11	10	10	30
21 to 25.....	.....	8	1	5	20
26 to 30.....	.....	.....	.....	.....	.....
31.....	.....	.....	.....	1	.....
	100	100	100	100	100

ARROYO CONTROL AND REVEGETATION IN ARIZONA

By E. L. Beutner¹

STUDIES were begun, in 1936, in Arizona with a view toward developing methods of controlling arroyos and revegetating valley alluvial flats in the Southwest, especially under conditions found in the southern part of Region 8. These areas at one time furnished abundant feed for cattle, in many instances supporting heavy stands of wild grass which was often cut for hay. The alluvial flats range in size from small elongated areas which rise at the foot of mountains and extend in fan formation toward the central part of intermountain valleys, to broad alluvium-filled valleys which form major stream tributaries. In most cases the alluvial flats are now drained by vertical-walled arroyos of recent origin. These arroyos are gradually encroaching throughout the flat areas to dissect them completely and produce a "bad-land" condition. While the soil consists of deep alluvial deposits, the more friable surface soil, together with the grass cover, has been removed by erosion so that a highly erodible soil is left exposed. During wet weather this soil puddles and seals over to such an extent that very little moisture penetrates. As a result, only deep-rooted shrubs and a few annual weeds are supported; this allows both gully and sheet erosion to proceed at a constantly accelerated rate.

Not only is the productive rate of these alluvial flat areas being diminished, but their erosion is furnishing an even greater menace to agricultural lands, irrigation ditches, and storage reservoirs. Studies of the silt content of run-off waters in the Upper Gila River drainage basin indicate that at least 20 percent of the silt load of the Gila River is contributed by one tributary—the San Simon Valley, which is a typical example of a large alluvium-filled valley cut by a recent arroyo. In addition, hundreds of smaller drainage-ways are tearing out the thick alluvial deposits of smaller valleys and dumping them into the main stream channels.

In many instances the beginning of gully erosion may be traced to poor land management with too great concentration of livestock and trampling and overutilization of vegetation. Many of the arroyos, how-



Brush Spreaders Retard Run-off, Increase Soil Moisture, Contribute to Vegetative Growth.

ever, started from ruts of old roads and trails, and a few are the result of plowing and later abandonment of formerly sodded areas. The problem as it now stands is to devise methods by which gully cutting may be checked and, at the same time, to rehabilitate the land, wherever potential values exist, so that vegetation may become reestablished.

The area selected for the study lies south of the city of Safford, Ariz. Here a small wash originates in the foothills of the Graham Mountains, and extends northward for 2 miles through relatively rough country. At this point there is a change of gradient and the stream breaks into a vertical-walled arroyo which cuts through a broad alluvial flat. Several smaller arroyos also traverse the flat, making for very rapid concentration of water and run-off after a rain. The

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Diversion Dam Bridging an Arroyo, Diverting Water to Flat Lands, Effectively Backing up 10 Acre-feet of Silt.

area of the entire watershed is 3,014 acres of which 456 acres lie in the alluvial flat. Before the cutting of the arroyo, water which entered the flat area from the watershed above was spread naturally and contributed to an abundant growth of alkali sacaton (*Sporobolus airoides*) and tobasa (*Hilaria mutica*). Little concentration of water took place, so that irrigation canals and farm lands below were not seriously menaced by floods and loads of debris.

To check erosion of the arroyos and prevent further silt from being carried down, a number of earthen diversion dams were constructed. These dams divert flash floods from the arroyos to the remaining flat lands and also cause silting up of the arroyos themselves. A series of contour spreaders was installed to provide an even distribution of water and prevent further erosion on the flat lands. Several types of spreaders were used including wire spreaders where the volume of water was great, brush spreaders where lesser quantities of water were dealt with, and earthen spreaders where local gullies and uneven ground occurred. Two years' results have shown that this system of structures is effective in caring for flood waters as well as starting the filling of the arroyos. Since the life of these structures is limited, however, it is necessary to reestablish a vegetative cover to complete the stabilization of the area. The area had been denuded of all vegetation except a few shrubs such as creosote bush (*Larrea tridentata*), mesquite (*Prosopis juliflora*) and salt bush (*Atriplex polycarpa*), and it was apparent that artificial revegetation methods would have to be used to obtain a grass cover that would be effective in controlling erosion.

Earlier experimental work in reseeding denuded areas of this kind had indicated that little success can be expected unless the surface of the soil is loosened to allow better penetration of water and to create more

favorable conditions for seed germination. Several methods for creating this condition were attempted. The first method, which also produced most rapid results, consisted of spreading native-grass straw containing some seed over the bare compacted soil and disking it in. This created a mulch which not only increased the absorptive and retentive power of the soil but also established the seed which otherwise would have been blown or washed away. As a result of this treatment an abundant growth of vegetation, consisting chiefly of annual grasses and weeds but also a few perennial grasses, took place during the first season.

This cover of annual plants which included purslane (*Portulaca oleracea*), annual grama (*Bouteloua barbata*) and (*B. aristoides*), fingergrass (*Chloris virgata*) and pigweed (*Amaranthus palmeri*) provided a further check on erosion and rapid run-off and served as a nurse crop while the more desirable range grasses became established.

After the second year a number of perennial plants had established themselves in areas which had been reseeded. Among these plants which give promise of forming a permanent cover are sacaton (*Sporobolus wrightii* and *S. airoides*), rothrock's grama (*Bouteloua rothrockii*), chamizo (*Atriplex canescens*), feathergrass (*Andropogon saccharoides*), vine mesquite grass (*Panicum obtusum*), and Johnson grass (*Sorghum halepense*). In addition, a number of introduced species including African bunchgrass (*Eragrostis lehmanniana*) and reed-grass (*Phalaris tuberosa*) are showing satisfactory results.

A second method which was used to establish vegetation involved disking seed into the bare soil without use of straw mulch. This method, while not as effective as that using straw, provided for the establish-

(Continued on p. 202)

Range Utilization Surveys and Procedures for Follow-up

By J. L. Lantow¹

IT is common knowledge that the range lands of the West have deteriorated as a result of the use and management to which they have been subjected in the past. It is equally well known that erosion has accompanied and followed this deterioration. For the permanent rehabilitation of our ranges therefore we must first change or modify the management and use; and this change with the establishment of the basis of proper use, provides our Service the key to conservation operations planning.

Range management practices have varied greatly in different parts of the West, but for convenience they may be grouped in two general areal classifications as follows:

1. Areas where some period or seasonal use is forced upon the operators by physical and climatic conditions.
2. Areas where yearlong grazing could be practiced.

In the sections where bunchgrass and browse dominate and where cold temperature and snow are factors to be contended with, the livestock management generally operates in separate winter and summer grazing units. But in the sod-grass areas, under similar climatic conditions, pasturing on wheat fields or stubble is practiced, or lot feeding, during fall and winter months. In both the bunchgrass and the sod-grass areas, a period or seasonal use forces itself into operation.

The operators, however, when using these grazing units by periods or seasons, have not always considered that there is a proper time of range readiness when livestock should be taken off or put on a range. The readiness of a range may be influenced by physical conditions of the soil, such as too much moisture, or by climatic conditions which may affect the growth of the



The grass on the left side of the fence has reached a higher volume growth, due to full protection from grazing. Proper management will produce similar results in the composition and density of the stand of desirable forage grasses. The grass on the right side has been heavily grazed by Navajo sheep.

plants and hold back or accelerate their readiness for use. And there may be many other reasons for timely changes in grazing. In sections of the West where yearlong grazing is practiced it usually is not only necessary to adjust numbers of livestock, but rotation or deferred grazing should be installed in the management plans. The two practices are equally important.

For the successful establishment, by artificial revegetation, of a perennial grass cover on denuded and depleted ranges a system of management must be initiated to allow the young seedlings at least one or two growing seasons without grazing. With several pastures, or a proper system of grazing, a seasonal rotation plan may be used to give protection to such areas for the necessary time. The rotation grazing may thus be planned with a progressive seeding program. The total area to be revegetated may be divided into smaller areas which will be seeded in successive planting seasons.

There are many factors in livestock management which may be incorporated into operations for the financial benefit of the operator and the protective benefit of the range. A management plan is essential, and it should include the basic factors of proper management for the locality. This does not mean, how-

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ever, that changes, modifications, and adjustments are not to be made as operations indicate that they are needed. The plan and the estimated numbers of livestock should be considered as only the beginning of the program. Any specific plan must be adjusted to changes forced upon us by unpredictable natural conditions. Likewise, we shall often wish to correct mistakes or to incorporate better practices.

In studying our operations, we shall in the future always consider such items as (1) methods of use, (2) time of use, (3) intensity of use and (4) forage or feed reserve necessary and advisable. These items surely point to a constant and continuous study of the range business. In our work with the operator, we might call these observations "performance checks" or "follow-ups." In making these observations we have an unusual opportunity to acquaint the operator with the program as a whole, to guide and instruct, and to work with him in analyzing performance.

In relation to this part of the work it will be helpful to list points to be considered in the range follow-up, or observance of performance activities. These important points are:

1. To secure the best possible vegetative cover that is consistent with economical management and the proper conservation of soil and water.
2. To consider control measures, such as structures, to be installed as justified by anticipated benefits.
3. To evaluate existent range practices and conditions by means of range utilization surveys.
4. To instruct the operator in the factors of scientific principles underlying plant care or management and livestock production. Guidance in the management of range and livestock must accompany the instructions so that the operator will understand the correlation of plans and practices. Records of livestock sales, purchases, increases, times of movement, and death losses for pastures and for the ranch as a whole should be kept up to date so that data can be put to immediate use when adjustments are needed.

It has been noted above that range utilization surveys should be included in performance activities. This should be emphasized, as there is no better way to establish proper stocking than by observing the use of a pasture or ranch. The same amount of feed is not grown year after year on a pasture or ranch, nor is there a very well established percentage of fluctuation in production. It is true, however, that we try in the beginning to establish a rate of stocking that is consistent with the quantity of forage available. In this we keep in mind the retaining of sufficient reserve not only to protect against erosion and allow for main-

tenance and recovery of vegetation but, also, to serve as a "back-log" for livestock during times of lessened forage production. A utilization survey, therefore, consists of finding out how the livestock numbers and the feed production will coincide for the duration of the total grazing period—not only for the ranch as a whole but for separate pastures as well. If we accept the old saying, "The eye of the master fattens the cattle," it should be doubly appreciated that "Eternal vigilance and observation allow timely adjustments to forestall erosion."

Utilization surveys would not be made at the same time in different parts of the country. On seasonal or year-long ranges they would probably be made at different times of the year. On any range, however, it would be well to take stock of forage and feed resources at the end of a production season. On grazing lands it is generally considered best to make the livestock fit the feed, since it is difficult to make the feed fit the livestock.

The relative palatability—percentage or extent of different species of plants—should depend largely upon two factors: (1) That if possible enough vegetation be left satisfactorily to handle erosion; (2) that the percentage of use between the different species be subject to change in different plant compositions so that the desired species will not be penalized. A greater percentage of use may be safely allowed on a good vegetative cover in heavy production years, and vice versa in years of light production. Each pasture should be analyzed on its own merits as to utilization.

In the method of procedure to be outlined in the following paragraphs, we attempt to make a diagnosis in the fall check so that we may estimate the number of livestock that can be safely kept during the winter and spring without damage to the range. Of course sufficient reserve must be kept somewhere on the ranch, at least enough to carry us until fall shipping in case no production follows. In making this estimate, we consider the amount of time the actual number of livestock were grazed, and also the percentage of forage use for the period. This necessitates the keeping of livestock records. The records should be kept by pastures as well as by the ranch totals. The method of procedure with the formula that may be used is shown on the following page.

The palatability, as shown in column 2 of the species tabulation, points out the percent of the species that will be eaten by livestock under proper range management. These percentages are arrived at by long and careful observation. Columns 4 and 5 represent the

percent of forage taken as of the first and second dates of inspection. The "percent of forage utilized" is determined by dividing the "utilization factor" of the first inspection by the total "palatability factor," and this is repeated using the "utilization factor" of the second inspection. The "actual animal months use" figures are determined from records kept by the operator.

There are many factors to be considered in making range utilization surveys. For convenience, the important ones are herewith listed:

- 1. The method of use on the area—yearlong, deferred, or rotation.
- 2. The variation in established palatabilities. These variations may be due to the combination of species within the pasture, or to the time of use.
- 3. The time element; that is, the amount of the time period that has been utilized previous to the surveys and the amount of the use period that remains.
- 4. Regrowth following the normal growing period.
- 5. Numbers, kinds, and classes of livestock.
- 6. Time of range readiness or condition.
- 7. Percentage of use of principal palatable species.
- 8. Cut in carrying capacity for protection of soil and plant vigor.
- 9. Timely adjustments in management.
- 10. The amount of reserve left for erosion protection.
- 11. Any changes in pastures, boundaries, or acreages.

It is important that the work be done with the cooperator, prior to market periods, if at all possible. Findings from these use surveys should serve as a guide to the operator in handling his ranch. In going over the ranch for utilization surveys, he is given a chance to make timely adjustments in his management plans and to observe the use being given to the different plants. For example, he may find that he should change his palatability lists in relation to proper use, as indicated by the utilization in the composition of plants in a particular pasture.

The benefits of range performance work (follow-up work) have been stressed, but we should not fail to point out the qualifications for a man doing this job. A range examiner sent out on such work must have experience behind him, and he must have the necessary knowledge and understanding of ranching. He should be qualified by education and training. He should have a suitable personality and approach for dealing with ranchmen. He must have ample time to devote to the work.

It requires a great deal of time and thought to make a success of ranching and to handle the range so that
(Continued on p. 204)

SOIL CONSERVATION SERVICE RANGE
UTILIZATION SHEET

Cooperator: John Jones.
Examiner: J. Doe.
Field No. 3, cow pasture.
Dates inspected Oct. 15, 1937.
May 1, 1938.
Average date growth begins June 1.
Average date growth stops Nov. 1.
Average number months in growing season . . . 5.
Total number months in grazing year 12.
Estimated percent of normal forage production . 90.

Species tabulation

Forage species	Com- position of total peren- nial vegeta- tion	Palata- bility	Palata- bility factor (palata- bility× percent of com- position = P. F.)	Degree of utili- zation		Utilization fac- tor (percent of utilization×per- cent of compo- sition=U. F.)	
				First inspec- tion	Second inspec- tion	First inspec- tion	Second inspec- tion
	Percent	Percent		Percent	Percent		
B. gracilis	40	85	3,400	35	85	1,400	3,400
H. jamesii	15	60	900	50	80	750	1,200
S. cryptandrus . . .	5	35	175	30	60	150	300
A. tridentata	15	20	300	5	20	75	300
Total			4,775			2,375	5,200

	First inspec- tion	Second inspection
Palatability factor (P. F.)	4,775	4,775
Utilization factor (U. F.)	2,375	5,200
Percent of forage utilized	49.7	109
Actual number of animal months (A. M.) use .	1,000	2,010

The total percent of forage utilized (109)×the animal months used at the end of the first inspection (1,000)÷the total animal months used (2,010)=the correct degree of utilization in percent at the end of the first inspection, or 54.

Total number of animal months used for the year: Recommended, 2,010; Actual, 2,010.

The recommended animal months of grazing remaining after the first inspection is expressed in the following formulas:

A. M. used 1,000×(P. F. 4,775—U. F. 2,375)÷U. F.
2,375=A. M. use remaining 1,010
A. M. use remaining 1,010÷months remaining 7= num-
ber of animal units 144
By calculating in percent of proper use only:
A. M. used 1,000 : percent of growth or feed used
49.7 : : x : percent remaining for proper use (100 —
49.7=50.3) 50.3
x=number of A. M. for proper use remaining 1,012
A. M. remaining 1,012÷months remaining 7=number
of animal units 144

Suggested palatability changes

Species	Present pala- tability	Suggested palatability	Reasons for change
H. jamesii	60	70	
S. cryptandrus	35	50	

Permanent Cover in Irrigated Orchards

By Charles B. Ahlson ¹ and George Hutchinson ²

IT is an accepted truth that a permanent cover of close-growing vegetation is of great value in controlling erosion. Dr. Bennett recently made this statement: "Close growing plants have emerged from all investigations as a fundamental principle of soil conservation. The use of vegetation will play a major part in the compromise which farmers eventually will work out with nature. Some compromise is necessary if crops are to be harvested and the productiveness of the land still maintained."

There are many questions yet to be answered, however, regarding the practical and economic limitations in the use of permanent cover. Can permanent cover crops of perennial and annual grasses and legumes be used in irrigated orchards in such a way that they will reduce erosion and cost of cultivation and at the same time maintain the average or more than average production and quality of clean-tilled or winter cover-cropped orchards? Will they increase the cost of pest control? Will they increase loss from rodents? Will they reduce production as the result of competition? Will such a system be practical in different localities and under varying climatic and physical conditions?

The following series of observations, made in various fruit-producing areas throughout California, are not intended to answer all these questions but are submitted as an indication that there is need for more research along this line.

Permanent Cover in Deciduous Orchards

Grower No. 1 has a Bartlett pear orchard, consisting of 3 acres. It is located at the end of Clark Street, half a mile south of Placerville in El Dorado County, Calif., in the center of a pear-producing area. The trees were planted in 1916 and have not been cultivated since that time. The trees are growing on slopes up to 30 percent. Twenty-five to fifty percent of the topsoil had been removed previous to the planting of the trees. The trees are normal and uniform in size, vigorous and of a dark green color.

The irrigation practice consists of "wild" flooding from furrows constructed across the slope, the water being spread by the dense permanent cover crop. The average seasonal application of irrigation water is about 20 inches per acre, and the cost is about \$9 per acre.

¹ Regional agronomist, section of agronomy and range management, Soil Conservation Service, Santa Paula, Calif.

² Assistant soil conservationist, Soil Conservation Service, Santa Paula, Calif.

The usual fertilizer practice consists of the application of about 400 pounds of ammonium sulphate per acre annually, at a cost of about \$6 an acre.

The perennial grasses, legumes, and annual weeds are mowed with a scythe from time to time and the cuttings left in place to form a dense mat of protective covering. The green growth reduces the fire hazard to a minimum.

The production figures for this orchard, obtained from the packing house and including the years 1928 to 1937, show a range of from 877 packed boxes, the lowest production, to 1,795 packed boxes, the highest production in the 10-year period. The 1937 production was 1,512 packed boxes. The average for the 10-year period was 1,296 packed boxes.

The production of pears which were handled by the packing house during this 10-year period averaged approximately 200 packed boxes per acre, while the yield of this particular orchard for the 10-year period averaged 432 packed boxes, or better than twice the average yield.

The quality of the fruit was above average. This is shown by the income received per box. This exceeds the average for the packing house of 2 to 17 cents, and averages 8 cents per box more than the house average.

The grower is thoroughly satisfied with the results he is obtaining through the practice of permanent cover. He tells us that operation of this particular grove would not be practical if it were necessary to cultivate—this because of the excessive slopes on which the trees are growing. He reports that his operation costs are low and that it requires less irrigation labor with this type of "wild" flood irrigation.

Similar reports could be recorded on 3 other orchards in this area. The figures from these orchards indicate that the production exceeds the average by 100 to 200 packed boxes per acre, and that the quality is equivalent to or above average.

Grower No. 2 owns a Bartlett pear orchard consisting of 33 acres located 3 miles east of Placerville on Highway No. 395 near the village of Camino, El Dorado County, Calif. The owner formerly operated 130 acres of orchard in this parcel on which the production was strictly marginal, principally due to severe erosion caused by winter rainfall and irrigation water and inadequate infiltration of the water.

In 1937 a new manager with considerable training in biochemistry was appointed and he abandoned approximately 100 acres of this planting and concentrated his efforts on the best portion, consisting of 33 acres. The slopes range from 3 percent to 25 percent, and the erosion was very active prior to 1937.

The new manager recognized that erosion and improper irrigation were probably responsible for the decline of the trees. In October of 1937 he seeded the 33 acres to ladino clover, vetch, and rye, and mulched the orchard with hay from an adjacent field of volunteer cover. Ammo-phos was applied at the rate of 400 pounds per acre. The fertilization resulted in an especially heavy cover crop and erosion was negligible, although 1.32 inches of rainfall occurred in 21 minutes during one storm. The planted cover crop was mowed once late in the spring of 1938, and all cultivation has been discontinued.

The manager states that irrigation has been greatly simplified and that there is practically no run-off of irrigation water this season. He intends to continue with permanent cover without cultivation and believes it is the proper program to follow in view of the results others have had with permanent cover throughout the past 20 years or more.

As a result of 1 year of this program the trees have improved in condition and the yield for the 1938 season is very satisfactory, considering the brief period of improvement. It appears, according to the manager, that an increase of at least 20 percent in yield was attained this year, although this may not be conclusive as it is a year of high yields in this particular area. The response and recovery of the trees are outstanding, however, and it is the belief of the management that the 33 acres can be completely rehabilitated and that profitable crops can continue to be produced under this system of permanent cover.

Ukiah, Calif., is located 115 miles north of San Francisco in a rich fruit-growing section. An efficiency study of Bartlett pears in this area, conducted by the Extension Service and reported in November 1936, shows an average yield of 6.9 tons of fruit per acre for the 14 pear orchards studied. The average yield of the 7 high orchards was 9.3 tons per acre, and that of the 7 low orchards was 4.1 tons per acre.

For comparison, it may be sufficient to record the practices and results of one permanent cover cropped orchard consisting of 12 acres of Bartlett pears planted in 1888. This orchard is located 7 miles southeast of Ukiah on the River Road. These trees are growing on bottomland and the soil is 6 feet or more in depth. Four of the twelve acres were reset in 1919. The

owner practiced clean cultivation prior to 1923 and this orchard has been in permanent cover for 15 years.

The source of irrigation supply is the Russian River, and a normal annual water use is about 24 acre-inches. The owner reported that he had difficulty in obtaining penetration of the irrigation water when the grove was clean cultivated, and he observed the ease with which the soil took water when irrigating an alfalfa planting on an adjoining parcel. As a result of this observation, the grower decided to discontinue all cultivation in the pear orchard in order to establish a permanent cover of clovers, Italian ryegrass and some annual grasses and weeds. The grower does not mow this cover.

His fertilizer program consists of applying a small amount of sheep manure obtained from a band of sheep maintained on the farm, and, in addition, a small amount purchased from time to time from neighbors.

The trees are in very good condition and show a deep green color and uniformity of growth. During harvest season the land is disked very lightly between each row to eliminate the irrigation ridges. By this he is able to avoid bruising the fruit as it is hauled from the orchards.

Crop yields secured from the packing-house record on 9.31 acres of the total show that from 1926 to 1937 they ranged from a low of 15.7 tons per acre to 25 tons per acre and averaged 17.8 tons of pears per acre over this 11-year period.

It appears, therefore, that the average yield of this orchard under a program of permanent cover was nearly three times the average of all those studied, and over twice the average of the seven high pear orchards that were reported. The efficiency study also reports that this orchard produced the highest acre-yield and income of those investigated.

Pest control consists normally of eight applications of arsenate spray, the cost being about \$20 per acre. This program is similar to that followed by other growers in the area who successfully control pests, particularly codling moth. Codling moth is the major pest on Bartlett pears in this area, and it is necessary to follow a consistent spray program in order to produce clean fruit. The amount of wormy fruit for the 1938 season was not obtainable; the owner stated, however, that no shipments had been rejected up to the time the inspection was made, and he believed the losses would not exceed 1 percent. Gophers and other rodents are satisfactorily controlled by traps and the flood irrigation which is practiced.

The owner is thoroughly satisfied with the results



Above. — Permanent cover with high production in a southern California avocado orchard.



Left.—Wild barley, bur clover and annual bromegrass form the cover in this fine lemon orchard, uncultivated for 15 years.

he is securing from his orchard under a program of permanent cover, and he intends to continue the practice. He definitely stated that it was his opinion that additional fertilization and pest control are not necessary under such a program.

Permanent Cover in Avocado Groves

In southern California there are many avocado growers who are using permanent cover in their groves. The data on one 15-acre grove, located on the Vista C. C. C. camp area near Fallbrook in San Diego County, will be included here. These avocado trees are 11 years old, and the soil has not been cultivated since the trees were planted. The cover crop consists of Bermuda grass, bur clover, and some annual

weeds. The cover has never been mowed or disturbed except where a shovel was used to facilitate the flow of irrigation water.

The grower has used and observed three methods of irrigating. The irrigation water is applied through a system of furrows and basins, straight furrows, and under-tree sprinklers. He is of the opinion that the under-tree sprinkler is most satisfactory and he is installing such a system over the entire 15 acres at a cost of about \$200 per acre.

The production of these trees is very satisfactory, as is the quality of the fruit, and the gross income for the year was \$5,400. The crop history shows there has been progressive increase in the yield each year. The yield for 1936-37 averaged 5,512 pounds of first-

grade fruit per acre, which is above average for the area.

The pest control consists of a light dusting with sulphur about once a season at a cost not to exceed \$5 per acre.

This grower is very enthusiastic about permanent cover and believes that his success in producing a high yield and quality of fruit can be partially attributed to the fact that he is not destroying by cultivation the high percentage of feeder roots located immediately under the cover.

There is no soil loss or any appreciable run-off resulting either from irrigation or winter rainfall, even under the occasional high intensity precipitation, from the slopes that range from 5 to 15 percent. The grower applies about 20 acre-inches of irrigation water from two wells at a cost of \$6 per acre for power.

The fertilizer program consists of the application of about 10 tons of dairy manure to the acre every other year and 3 pounds of ammonium sulphate per tree annually. At current prices the cost is about \$45 per acre. Considering the yield and quality of the fruit the expenditure appears warranted, but, in view of the experience of other growers, it is questionable whether the organic fertilizer is required.

Permanent Cover in Citrus Groves

The factual data have been collected from the records of six orange growers and three lemon growers who have had permanent cover without cultivation for 2-, 5-, 10-, and 15-year periods. The practices consist of annual volunteer cover with basin irrigation and overhead sprinklers, permanent cover of ryegrass with under-tree sprinkler, permanent cover of Bermuda grass with furrow, and basin and flooding irrigation, all without cultivation. One grower has found it profitable to pasture the permanent cover with geese, providing they are properly rotated to different areas in the orchard.

Data from at least two representative groves could be recorded, but it may suffice for the purpose of this article to state that none of the growers interviewed would change to his former clean-cultivated practices. One of the growers has had permanent cover for 15 years, following 10 years of annual cover crops and clean cultivation. This particular grove, Eureka lemon trees, planted in San Diego County in 1913, has the 500 original trees and this indicates that rodents have been successfully controlled. The production of 10 boxes per tree is above the average for the district.

A 29-acre orange grove planted in 1928 near Santa Paula, Ventura County, Calif., on slopes varying from 5 to 30 percent, with annual volunteer cover, no cultivation, and irrigated with an overhead sprinkler system, was reported to be the second highest yielding 10-year-old grove in the State last year.

Our observations on 23 permanent cover-cropped irrigated orchards that had been managed under this system for 2 to 22 years convince us that in no instance would the owner change to clean cultivated practices. It was found that the rather large cost item of cultivation has been reduced to a minimum, usually not to exceed \$5 an acre, where formerly, as in one instance, the cultivation costs amounted to \$65 per acre. The saving in this item may be held in reserve to offset any added cost which may develop from the use of a permanent cover.

The statements made in this paper are the results of a preliminary survey and, while suggestive and interesting, should not be construed as a recommendation of the general use of permanent cover crops in orchards. Additional work will be required before the relationship between permanent cover and pests, rodents, fire hazard, quality, and production can be determined and fully evaluated.

While further and more complete investigations would indicate many of the causes or reasons for the results as herein set forth, it should be remembered that our observations were for the purpose of making a preliminary determination of the value of permanent cover in erosion control.

Farmers on all Soil Conservation Service projects are seeking more efficient methods to conserve the soil. Wherever permanent cover crops are used, the practice is meeting with enthusiastic response.

Evaluation studies are being set up on the Soil Conservation Service projects and camp areas for the purpose of stimulating further thought and investigation of this fundamental soil conservation practice.

ARROYO CONTROL

(Continued from p. 195)

ment of seed and also improved the absorptive power of the soil.

Bermuda grass sod (*Cynodon dactylon*) was used to stabilize and protect earthen structures from washing. The sods formed a solid mat on these structures in 1 year.

Plantings of willow, giant reedgrass, and batamony in the silt deposits above diversion dams, have formed a dense growth which aids greatly in dissipating the

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Collecting black locust seed in Lewiston, Idaho.

Hardiness of Southern Idaho Locust

DURING the past 3 years the Soil Conservation Service has secured by collection or purchase approximately 150,000 pounds of black locust seed. Most of it came from southern Idaho. This memorandum has been prepared in response to numerous inquiries as to hardiness to be expected of stock produced from southern Idaho seed.

Technicians of the nurseries section of the Pacific Northwest region are of the opinion that Idaho seed is the equal of and possibly superior to that available from any other known source. The seed is large, well developed, and averages an extremely high cutting test. Plantings to date have been very satisfactory.

A few data concerning site factors of Idaho locust may suggest additional reasons for considering this State as a desirable source for locust seed. The approximate elevation range for the area is 2,700 to 4,500 feet. The latitude is 43° N. The climatological data for Boise and Jerome Counties is shown below. Both counties are heavy seed producers.

These data indicate that hardiness is a prerequisite for plants grown in the area. Furthermore, it is believed that there is a direct parallelism between desirable cereal and tree seed sources. For the former it has been demonstrated that seed from

	Boise County	Jerome County
Average elevation.....	2,700 feet....	3,572 feet.
Average summer temperature..	70.9° F.....	67.6° F.
Average winter temperature...	32.0° F.....	25.9° F.
Average maximum summer temperature.....	85.9° F.....	86.4° F.
Average minimum summer temperature.....	24.2° F.....	16.0° F.
Highest summer temperature..	121° F.....	105° F.
Lowest winter temperature...	-28° F.....	-27° F.
Average date first fall killing frost.....	Oct. 13.....	Sept. 20.
Average date last spring killing frost.....	Apr. 27.....	May 20.
Average length growing season.	169 days....	123 days.

plants grown under rigorous conditions in northern States or at high altitudes is more desirable than that produced by plants where conditions are less severe. Southern Idaho is a recognized seed producing area for forage and cereal crops, the seed finding a ready market throughout the United States.

Throughout the area under discussion it has been found that black locust trees are vigorous and rapid growers. They are remarkably free from parasites. Seed crops are certain, yields are high, quality is excellent; hence seed can be produced at low cost.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



HUMUS: ORIGIN, CHEMICAL COMPOSITION, AND IMPORTANCE IN NATURE.—SECOND EDITION. By Selman A. Waksman. Baltimore, Md. 1938.

Since the first edition of Dr. Waksman's book was reviewed for this department (July 1936 issue), it has been widely read and applied in the work of our Service. And now, but 2½ years after its original appearance, we have the extraordinary advantage of a revision which takes into account the rapidly growing recognition of the significance of organic matter in agricultural practice and soil conservation, particularly the latter.

The volume now may be considered a standard work of reference. It is a keen and critical interpretation of the facts concerning humus in the natural organic cycle with aspects for practical application of the knowledge. The logical order of arrangement, from "nature and characteristics and types of humus and its role in plant nutrition" to "humus and soil conservation," is an important feature, as it presents the highly complicated subject without confusion and points to the numerous special problems in such a manner that ready reference is facilitated.

There is an entirely new chapter in the second edition, and its title is "Humus and soil conservation." A great deal of pertinent information is packed into this chapter to show the relation of humus to soil fertility, the reason for humus losses through cultivation and through wind and water erosion, and the importance of, or rather the "prime necessity" for, constant maintenance of soil organic matter in a soil-conservation program.

To show that erosion of the soil as well as deterioration due to improper systems of cultivation are closely related to soil organic matter Dr. Waksman points to the results of 50 years of field experiments at the Woburn Experimental Station. These results, analyzed by Russell and Voelcker, are given in support of the conclusion that soil deterioration under continuous cropping can be prevented only by the use of farmyard manures with crop rotation. Going further, the author cites Richardson's "Nitrogen cycle in grassland soils," a 1938 publication, to emphasize the increase in organic matter content through use of lime. Continuing this line of reasoning, Dr. Waksman writes: "In semiarid areas, the alternate summer-fallow and wheat system of farming was found to be most destructive to the humus supply of the soil. In the application of organic residues to increase the humus content, it is essential to supplement low-nitrogen-containing materials, such as straw, with sufficient nitrogen, so that there is 1 part nitrogen for every 12 parts of carbon." And here is cited the recent article (1938) by Holtz and Vandecaveye, "Organic residues and nitrogen fertilizers in relation to the productivity and humus content of palouse silt loam."

The citation series throughout the book constitutes unusually interesting studies which reveal the author's ability for critical interpretation of all aspects of his subject. In this second edition he has used to advantage an enormous amount of literature on humus; in particular, he gives considerable space to the interpretation of the works of modern Russian writers. The bibliography has been enlarged to include most of this literature. There are now 1,608 references.

Chapter 8, under Origin and Nature of Humus, has been greatly enlarged to contain very valuable information about humus forma-

tion in composts of stable manure and of plant residues, and about the effects of green manure crops upon the soil.

For the benefit of those who are not acquainted with the first edition, the contents of the large volume is outlined briefly as follows: Humus in the organic cycle in nature. Nature and characteristics of humus, types, role in plant nutrition, changing conceptions concerning the chemical nature of humus and humic acids, and humification of organic matter in soils, and in composts with methods of determination. Origin of humus, isolation of definite organic chemical compounds from humus, chemical nature of humus, and humus formation in composts of stable manures and of plant residues, with studies of green manures. Humus in forest and heath soils, in mineral soils (field, grassland, garden, orchard), in peat and coal. Organic matter formations in water systems. Physical and physiochemical properties of humus. Decomposition of humus in nature, presence in humus of substances injurious and beneficial to the growth of higher plants. Utilization of various forms of humus for agricultural and industrial purposes. Soil humus and the science of pedology. Humus and soil conservation. Humus as an organic system. Methods of analysis of humus and of certain humus constituents.

ARROYO CONTROL

(Continued from p. 202)

force of flood waters before they reach the structures as well as hastening the filling of the old arroyos themselves.

Treatment of the area is thus resulting in a two-fold benefit: (1) It is removing the silt and flood menace to irrigation ditches, farm lands, and storage reservoirs below, and (2) it is restoring the productivity of an area which had deteriorated as a result of severe arroyo cutting and sheet erosion and was consequently denuded of its cover of vegetation.

Careful studies conducted during the process of arroyo filling and land revegetation are proving to be extremely helpful in adding to our knowledge of the processes of sedimentation and erosion and also in pointing the way to improved methods for controlling erosion and conserving moisture in the Southwest.

RANGE UTILIZATION

(Continued from p. 198)

erosion is either prevented or stopped. It is first of all a matter of observation, and then of good judgment. An early recognition of trends in range conditions is a prerequisite to making timely adjustments. Constant endeavor must be employed in the proper handling of a grazing area, in pointing out to the operator the objectives of soil conservation in the field, and in instructing and guiding him in the principles of proper use.

Report of the Chief Is Cited in Latest Compilation of Bulletins

For **REFERENCE**
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

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GOOD FARMING
DECREASES
SOIL EROSION

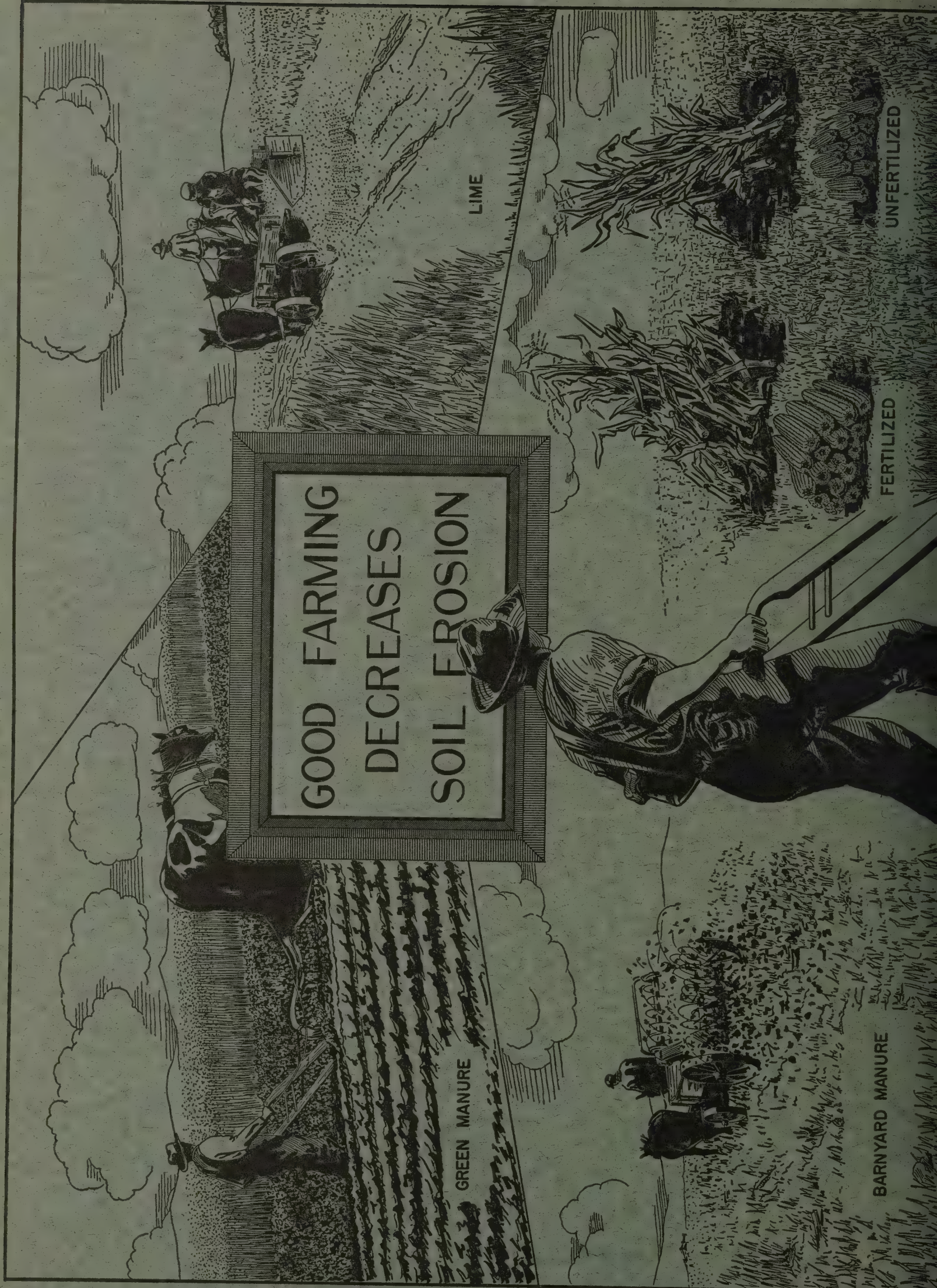
GREEN MANURE

LIME

BARNYARD MANURE

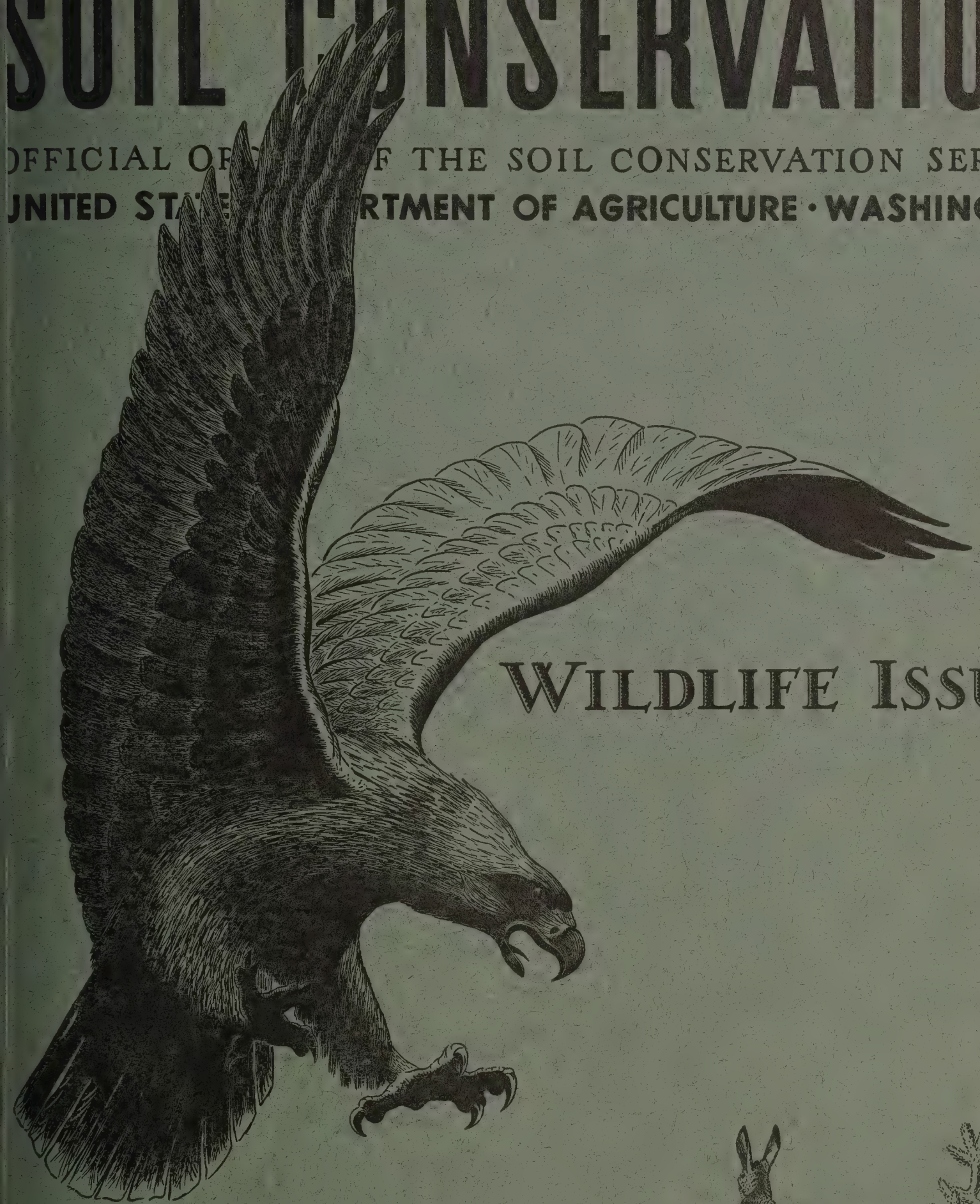
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SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



WILDLIFE ISSUE

MARCH 1939



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WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and co-operators of the Department of Agriculture engaged in soil conservation activities information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of \$1.00 per year, domestic; \$1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

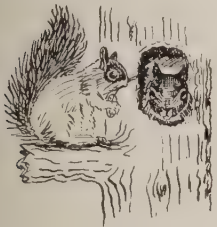
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H. H. BENNETT
Chief, Soil Conservation Service

MARCH • 1939

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FOREWORD

FUNCTIONS that considerably enlarge the scope of our activities have been assigned to the Service within the past few months. These new duties have laid on us heavy responsibilities that necessarily must modify our thinking and cause us to look closely to our administrative and technical organization. Yet now, as during the earlier life of the Service, our faith in the principle of a coordinated attack on land-use problems remains unshaken. I am convinced that we have effectively demonstrated the merit of this principle through our work during the past 5 years.

The rapidity with which soil-conservation districts are being formed is especially encouraging. The cooperative action of farmers and ranchers to create districts signifies that the American people are becoming increasingly aware of the urgent need for conservation of soil resources. I believe that every employee of the Service may be proud of his part in helping to bring about this new attitude. The complexity of the problems we are now facing in our enlarged program makes more essential than ever before the coordinated use of all the knowledge and avenues at our command.

In our efforts toward soil and water conservation, the biologist, no less than his fellow technicians in other fields, has won his spurs, and I am glad to see this issue of SOIL CONSERVATION dedicated to his work. The biologist seeks to turn wasted parts of

farm and ranch to the benefit of wildlife by covering the wounds of erosion with healing vegetation. He has developed techniques of great value to farmers for stabilizing critically eroded areas. At the same time, his success in improving conditions for wildlife has been the means of pointing out to many people the importance of soil defense as the basis of all conservation.

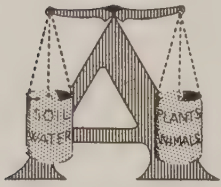
These are accomplishments already credited to the biologists; but biologists as well as all other technicians, will need to exert themselves still more in the future. The development of land-utilization projects undoubtedly will call for a considerable expansion of our wildlife work. Much needs to be done to improve our present conservation practices and apply them most effectively in the solution of flood-control, water-facilities, drainage, farm-forestry, and drought problems.

The development of soil-conservation districts makes possible the coordination of individual, State, and Federal forces for the conservation of soil and its resources, of which wildlife must always be reckoned as one. If we continue to apply ourselves in the future as we have in the past, and if we maintain a clear, broad perspective of our objectives, I am confident that our part of the work to rehabilitate the Nation's wildlife will produce the results all of us desire.

H. H. BENNETT,
Chief.

WHAT IS A BIOLOGICALLY BALANCED FARM?

By Ernest G. Holt¹



AMONG the several objectives of our wildlife management program upon which we have laid most stress is that calling for the establishment of a better biologic balance on the farms and ranches of the country. We have talked a great deal about this, and now many people are asking, "Just what is a biologic balance?"

I have anticipated such a question, and I have an answer: "There isn't any such thing!"

And now after that statement, it is necessary that I go much further and attempt to explain our reasons for using the term and to clarify its origin and meaning.

In the first place, we have used the term for want of a better one and because "the balance of nature" is talked about, loosely and widely, by that elusive individual, the man in the street.

If it is true that a biologic balance does not exist, it is equally true that Nature does dispose her various organisms in an elaborate system of checks and balances, one against another. Under natural conditions (barring cataclysms), it is very doubtful if any species has ever exterminated another. Despite all claims to the contrary, it is a matter of simple logic that it is impossible for predators to increase in numbers unless there has been a corresponding increase in the creatures they prey upon. When the augmented numbers of predators have brought the prey species back to lower population levels, then the predators also must fall off in numbers because of their diminishing food supply. Thus we have, not a balance in the sense of a static equilibrium, but such a balance as is represented by the simplest type of weighing apparatus. There is con-

stant seesawing up and down, but always a tendency toward reduction of the arc of oscillation, so that even violent upswings in population do not allow a species to get entirely out of control.

But I have been describing that idyllic state of nature before the advent of so-called civilized man. I do not believe that nature ever reckoned on the civilized members of our genus. I willingly recognize primitive man as a natural factor in the environment; but no primitive man ever invaded virgin territory with steam shovels, ditching machines, gang plows, and swarms of cattle and sheep.

We are faced now with a situation that bears not the slightest resemblance to a normal order. Nature's checks and balances have been everywhere disturbed, often upset, and in some instances completely destroyed. And, if we are honest, we will admit that we have at times paid a heavy price for our carelessness, or ignorance, as the case may have been.

You may ask: "What, then, is to be done about it? We are here; we have subjugated the country; and, because we are civilized, we cannot live in harmony with nature as did the Indians."

I will grant the first two premises, but I will not concede entirely the third. My thesis is that we can live with nature far more harmoniously than we have been doing. But we must make compromises. We must reverse our old ideas that nature owes us everything, while we owe her nothing. The very least we can do is recognize and obey natural laws.

Probably our worst offense has been the upsetting of the "biologic balance." The consequences have been widespread and far reaching and affect not only the plants and animals, but the very soil whence they spring. Our reckless stripping away of the vegetative

¹ Head, section of wildlife management, Soil Conservation Service, Washington, D. C.



cover of the soil has driven out the animals and invited in the forces of erosion, which are now exacting the terrific toll of 300,000 acres of land annually. This is equivalent to dumping into the ocean each year 1,875 farms of 160 acres each. It means that our failure to compromise with nature is each year depriving 1,875 families of their means of livelihood. If you think that I am straying from my subject, let me remind you that these farms are going down the river because we are not maintaining a reasonable biologic balance on them.

You may at once object that I am unwarrantedly dramatic, that total destruction of the land is an extreme result not likely to follow our thoughtless tampering with nature's balance. But have you considered that in the few generations of our national existence such tampering has already laid waste a hundred million acres, has stripped another hundred million acres of one-fourth to three-fourths of its topsoil, and has opened the way for active erosion on still a third hundred million acres?

Biology has to do with the whole flora and fauna—the biota. But how can you consider a plant or an animal apart from its environment? And is not soil just as important to a plant or an animal as air or water? In fact the relation is reciprocal. Plants, animals, and soils are so bound up in a highly intricate complex of interrelations that, in some degree at least, anything that affects one affects all the components of a given community. Upsetting the biologic balance has the more immediate effect on plants and animals, but soils eventually and inevitably are injured or destroyed. I have cited the effect upon soils because we have been able to measure it; after plants and animals have gone it is extremely difficult to arrive at a quantitative estimate of the original biota.

Notwithstanding these interrelations, which are sometimes obvious to him who would see, it is usually difficult to convince the human creature that he should shoulder the blame when he tips the scales on the

wrong side and something begins to happen that he has not bargained for.

For example, I have seen men who held that pocket gophers were responsible for the destruction of high mountain meadows which the gophers themselves had helped to build, and which they, through their working of the soil, had maintained in a high degree of productivity, from the recession of the glaciers until the invasion of domestic livestock. When the cattle and sheep had eaten the vegetation from these high mountain meadows and laid bare the soil, grazing pressure was not reduced to give the meadows a chance to recuperate. Erosion finished the job the livestock started, and the gophers took the consequences.

On the western range I have heard bitter complaint against the ravages of jack rabbits. Again let us look beneath the surface and see what we may find. Our first observation is that more cattle and sheep are being run than the range can safely support. The original grasses have almost disappeared, and their places have been taken by range weeds, mostly of the brushy type. With the change in cover type, and the destruction of natural rabbit predators which has been going on at the same time, the jack rabbits have increased and are, in fact, taking a heavy toll of what little grass is left. Now, on these western ranges, livestock numbers must be reduced to safe carrying capacity, so that the range may build back to the climax grasses.

Years ago I investigated a damage complaint which came from a small ranch in Arizona. Upon arrival I found a veritable oasis in the desert. The rancher had cleared a few acres of creosote bush, miles from his nearest neighbor, and by irrigation from a deep well was making the desert literally to blossom as a rose. Peaches, plums, grapes—fruits never before seen in those parts—were bearing heavily. Then the inevitable happened. The birds of the desert came in to the feast and the fruit was no more. Quail that never in their lives had tasted a peach came in flocks and



literally cleaned the trees. Thrashers, mockingbirds, verdins, all took their toll.

I cite this case as just another example of lack of forethought, as just another score against our common human failure to give heed to nature's laws. In an adjacent district fruit was being grown and harvested successfully, and the ranchers suffered so little damage from birds that they thought nothing of it. But there the ranches were in a block of considerable size, not just a patch of a few acres surrounded by an enormous expanse of desert; there was some semblance of balance between the fruit crop and the bird crop.

The robin and the cherry crop provide another case in point. Everyone knows that robins are capable of wreaking havoc in an orchard of ripening cherries. Not all of us, however, stop to think that often the robins more than earn the cherries they eat, through their destruction of insect pests; or that they apparently prefer wild cherries to tame. Would it not be the part of wisdom to let wild cherries grow up along our fences instead of so zealously putting them to the ax?

In the Midwest, high productivity and intensive agriculture have placed such a premium on every available square foot of soil that farmers have been moved to do things that we now know were ill-advised.

The old rail fence has been replaced by barbed wire to allow an additional "land" to be given to the plow, and to be kept scrupulously clean of vegetation lest the farmer be considered untidy. With the rail fence and the thickets that filled its angles have gone the quail and other birds that delighted the eye and ear of the farmer and helped to keep down the chinch bugs, potato beetles, and clover weevils that now overrun his fields.

The woodlot has been cleared from the hill to make more pasture. With the trees have gone the grouse and squirrels. The thin sod, trampled by too many cloven hoofs, has not been able to carry on the good work of the woods. Gullies begin to gnaw into the steep slopes—while the farmer hauls his fuel from town.

And the old swimming hole—surely we shall find that unchanged. But the hope is a vain one. That strip of trees and shrubs along the creek shaded too much potential grass for the dairy herd. With the vegetation went the only protection the creek banks had against the scouring freshets that have increased in violence as the uplands were denuded in their turn. The swimming hole, where the farmer himself used to catch trout whenever he could find the water free of his own boys, has given place to a chasm which stretches its jaws wide for the barn.

This also may appear melodramatic; but I have

deliberately chosen my illustration, and I can take you, not to one farm like this, but to dozens. And every one of them is out of balance biologically.

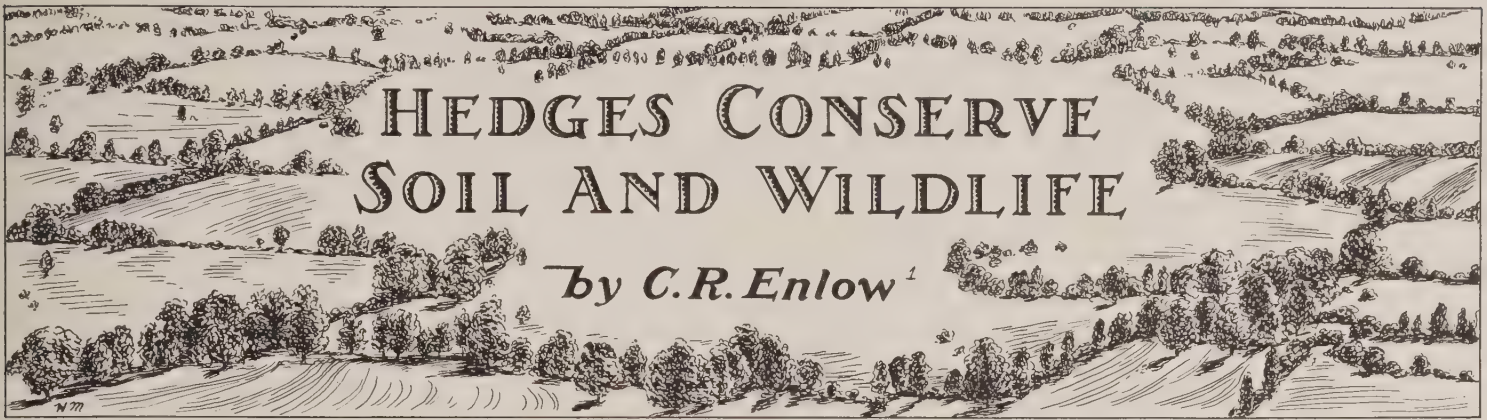
Just what do I mean by a biologically balanced farm? Not, as you may think, one that has reverted to its pristine condition. While you and I are just as much dependent upon the soil of that farm as are its old maples and oaks, our main dependence is expressed in terms of products of cultivation. Agriculture is essential to our existence, and the pursuit of agriculture involves a profound disturbance of natural conditions. It is unthinkable, therefore, that we could restore a semblance of the original balance.

Nor is it necessary. It is true that the production of agricultural crops demands the removal of a tremendous proportion of the native vegetation from the soil. But it demands neither the destruction of all native vegetation nor the exposure of all soil to the elements. On the other hand, the safety of our whole agricultural structure demands that a reasonable balance be maintained between soils, animals, and plants, both wild and cultivated.

I conceive a biologic balance as having been attained when destructive influences (admittedly necessary in agriculture) are compensated for by constructive or protective measures. In other words, when we so manage a farm as to conserve its natural resources of soil, water, vegetation, and wildlife, while producing a safe and reasonable volume of agricultural products, we are well on the way to this balance.

This does not mean turning the farm back to trees or grass. It does mean contour cultivation, strip cropping, and sound crop rotations to protect land bared by cultivation; it means safe grazing pressure on pastures; it means the maintenance of permanent vegetation on all critically erodible areas. Above all it means that we must make a careful study of the conditions as we find them, discriminate between cause and effect, and act in harmony with nature instead of at cross purposes.

When we have restored enough vegetation to protect our eroding soils, and in the process have given due thought to wildlife food and cover, the birds and small mammals will quickly respond. They will do their part by preying on the insect enemies of the plants, which in turn will check the run-off of rainfall, and allow it to soak into the ground to maintain the water table, to ensure perennial springs, to lessen flood crests in streams. Moreover, by careful husbandry, the fertility of the land we till may be built up so that we may obtain the same yields from fewer acres, and thus conserve our energy as well.



Hedges and tree rows used for field boundaries near Ailes, France, provide safe travel lanes by which game birds can move freely from one place to another. (Drawing made from photograph.)

IT SEEMS logical, in connection with planning erosion control, to make comparisons between our practically new agriculture and the agriculture of Europe where farming has been under way for many generations. While such comparisons may be subject to criticism because of differences in type of farming, soils, total precipitation, intensity of rainfall, etc., certain individual European practices are comparable, to some extent, with those used in some sections of this country. Probably the outstanding difference is that in Europe there is universal recognition of the need of crop rotation for the maintenance of soil and for the permanence of agriculture. The use of grass and legumes in the rotation, the importance of proper land use, careful productive management of pastures, and the use of hedges for field boundaries are given particular attention in Europe. It is in connection with the latter practice—the use of hedges—that this article is written. The advantages of hedges for erosion control and the preservation of wildlife, particularly birds, are immediately apparent to the observer studying European agricultural methods.

An opportunity was afforded me in 1937, in connection with the meeting of the International Grassland Congress, to spend 3 weeks inspecting the principal areas of grassland interest in England, Wales, and Scotland. Following this tour, which was made by some four hundred agronomists from all over the world, I spent 3 weeks in an individual tour of French farms with the idea of observing at first hand the farming practices and erosion-control methods employed in that country. Particular attention was given to crop rotation, field arrangement, pasture practices, and orchard cover crops. The use of hedges had not been given previous thought and, consequently, their prevalence was all the more impressive.

The first impression of hedges in England, where the trip started, was mainly one of annoyance. The hedges were high enough effectively to block a view of the fields from highways, and constant alertness was required to take advantage of the breaks in the hedges and the high points in the terrain to get a general impression of the agriculture.

Throughout Great Britain, where the agriculture is so predominantly grass management, the value of hedges for erosion control was not particularly apparent. In France, however, I observed innumerable hedges planted across the slope with the soil above the hedge 3 or 4 feet higher than the level of the soil below the hedge; there were also instances where the difference was as much as 5 feet. Due to the old system in France of dividing the farms so that each heir might have a separate parcel, the fields on the average are quite small. In many localities every field is bordered by a hedge. On sloping land this provides effective erosion control, as the hedges break the length of the slope. It is quite apparent, however, that the practice was not initiated with this idea in mind and that much more effective control could have been obtained had the hedges been planted on the contour. In some sections of northeastern France, I saw not only contour hedges but contour fences, contour cultivation, and contour strip cropping as well.

For the protection of small birds, the use of hedges seems ideal. In both Great Britain and France many coveys of partridges, resembling our quail, were in evidence. Invariably they were making headquarters in the hedges. I gained the impression that much heavier populations of birds were present in both Great Britain and France than in the United States, and there can be little doubt that the excellent cover afforded by the hedges is responsible for the larger numbers.

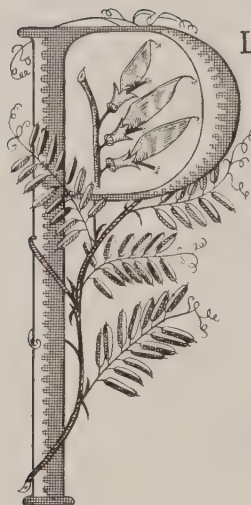
Hedges in England are usually very different from

¹ Head, section of agronomy and range management, Soil Conservation Service, Washington, D. C.

(Continued on p. 223)

LEGUMES FOR EROSION CONTROL AND WILDLIFE

By Edward H. Graham¹



PLANTING programs for the improvement of wildlife habitats have laid heavy emphasis upon the use of woody plants. Herbaceous species, however, are more valuable than their limited use would indicate, and among them the grasses and legumes are outstanding groups. They propagate readily by direct seeding, mature in a short time, provide important food and ground nesting cover for wildlife, and rapidly produce a protective blanket of vegetation useful in controlling erosion.

Many leguminous plants are proving so helpful to the soil conservationist and wildlife manager that the Service is giving careful consideration to this plant family. Within the United States there is a native leguminous flora of about 2,000 species. Among our crops there are nearly 50 legumes of commercial importance. Many of our native Leguminosae appear as pioneer plants on denuded areas, or occur most abundantly where soil is poor and grass is thin. Consequently they are exceptionally useful in revegetating eroded sites. Their function of enriching the soil through the fixation of atmospheric nitrogen by means of root nodule bacteria gives them an added value for soil conservation.

While the American farmer uses comparatively few legumes as food crops, a single native American game bird, the bobwhite, includes 88 different kinds of legumes in its normal diet. In the Southeastern States, so important are they as food for bobwhite that the number of native leguminous plants growing over the vast coastal "flat woods," areas little frequented and consequently not shot out by man, can be relied upon as an index to the quail population of the region. The bobwhite is not the only bird with a liking for these plants. The Gambel's quail is known to eat 30 species of legumes. The Arizona scaled quail utilizes a couple of dozen different kinds. The eastern mourning dove, mallard, California quail, and ring-necked pheasant eat the leaves and seeds of numerous species. The high protein content of leguminous seeds makes them particularly valuable as staple winter foods. Good use can

be made of leguminous plants if they are seeded to provide food adjacent to adequate woody cover. In some places light disking of the ground is all that is necessary to ensure the volunteer appearance of partridge peas, tick trefoils, and other native legumes.

A review of literature now in progress, and an examination of stomach records in the Bureau of Biological Survey, reveal, to date, that 244 species of leguminous plants are known to be used as food by 231 animals, of which 95 are mammals and 136 are birds. The following tables indicate the legumes most used by wildlife for food, and the animals which use them:

Legumes most used by wildlife

GENERA

Legumes	Number of wildlife species using legumes for food		
	Birds and mammals	Birds	Mammals
<i>Trifolium</i> (clovers).....	100	79	21
<i>Medicago</i> (alfalfa, bur clovers).....	56	41	15
<i>Lupinus</i> (lupines).....	36	23	13
<i>Melilotus</i> (sweetclovers).....	31	24	7
<i>Vicia</i> (vetches).....	26	22	4
<i>Cassia</i> (sennas).....	22	21	1
<i>Pisum</i> (peas).....	20	17	3
<i>Robinia</i> (locusts).....	18	9	9
<i>Prosopis</i> (mesquites).....	17	5	12
<i>Phaseolus</i> (beans).....	16	9	7
<i>Astragalus</i> (milk vetches).....	15	6	9
<i>Lotus</i> (birdsfoot trefoils).....	14	9	5
<i>Desmodium</i> (tick trefoils).....	13	10	3
<i>Lespedeza</i> (bush clovers).....	12	9	3
<i>Chamaecrista</i> (partridge peas).....	10	9	1

SPECIES

<i>Medicago sativa</i> (alfalfa).....	38	25	13
<i>Trifolium repens</i> (white clover).....	28	21	7
<i>Medicago hispida</i> (California bur clover).....	22	18	4
<i>Trifolium pratense</i> (red clover).....	18	11	7
<i>Pisum sativum</i> (garden peas).....	17	16	1
<i>Prosopis chilensis</i> (mesquite).....	17	5	12
<i>Melilotus alba</i> (white sweetclover).....	13	8	5
<i>Robinia pseudoacacia</i> (black locust).....	11	5	6
<i>Arachis hypogaea</i> (peanut).....	9	5	4
<i>Melilotus indica</i> (sour clover).....	8	7	1
<i>Sesbania macrocarpa</i> (sesbania).....	7	7	0
<i>Lespedeza striata</i> (common lespedeza).....	7	6	1

Wildlife species which use legumes most

Birds	Number of legume species eaten	Mammals	Number of legume species eaten
Bobwhite.....	88	California mule deer.....	29
California quail.....	31	Virginia deer.....	18
Gambel's quail.....	30	Rocky mountain mule deer..	11
Eastern turkey.....	25	Rocky Mountain bighorn...	11
Arizona scaled quail.....	23	California jack rabbit.....	8
Eastern mourning dove.....	19	Eastern cottontail.....	7
Ring-necked pheasant.....	17	Antelope jack rabbit.....	6
Common mallard.....	13	Merriam kangaroo rat.....	6
Greater prairie chicken.....	9	Sonora white-tailed deer....	5
Northern horned lark.....	9	Virginia opossum.....	5

¹ Biologist, section of wildlife management, Soil Conservation Service, Washington, D. C.

The widely consumed clovers and alfalfa are forage crops perhaps as much eaten by wildlife for their succulent vegetation as for their seeds. The lupines are primarily wild plants, while the sweet clovers occur in many places more as naturalized weeds than as crops. Many of the legumes belonging to the other genera listed are native, uncultivated species of interest to the wildlife manager because their maintenance does not require the attention demanded by cultivated plants. Except for Robinia, Prosopis, and Astragalus, the legumes are shown to be utilized more by birds than by mammals. Gallinaceous birds make the greatest use of legumes, and all the birds listed except the mourning dove, mallard, and lark belong to the Galliformes. Among mammals the ungulates apparently use legumes most, for we find 4 deer and a sheep in the list of 10. Certain woody legumes such as mesquite and black locust are used by wildlife, but the woody species are few in number, as 98 percent of the legumes that grow in the United States are herbaceous plants. Although leguminous species generally do not seem to be utilized by wildlife as extensively as certain nonleguminous woody plants such as the oaks, blackberries, elderberries, pines, and sumacs, nevertheless the widespread utilization of clovers, alfalfa, lupines, vetches, and many other legumes proves them to be of outstanding importance to the wildlife manager.

Among the leguminous plants most used by wildlife are a number of crops which are notably erosion-resistant, especially when they are sown with grasses or used in pasture mixtures. Among them is alfalfa, which is recognized as one of the principal foods of the sage hen, Columbian sharp-tailed grouse, and eastern bobwhite. The clovers vie with alfalfa as wildlife food. White clover is a preferred food of the prairie sharp-tailed grouse, is a favorite of the muskrat when available, and is consumed by ring-necked pheasant and sage hen. Red clover is nearly as promiscuously used, and is so much preferred by the woodchuck that, in the East, red-clover fields and woodchucks seem almost inseparable. California bur clover is another crop legume widely utilized by birds, especially by California quail; it has even been recorded from the stomachs of waterfowl, specifically baldpate, cinnamon teal, and green-winged teal. Garden peas are highly prized by wild animals as food, and among the two dozen animals known to eat them are the band-tailed pigeon, ring-necked pheasant, bobwhite, rose-breasted grosbeak, red-headed woodpecker, sage hen, and Baltimore oriole.

During the past planting season, the Service used for erosion-control purposes approximately a million

pounds of legume seed representing more than a dozen different species, exclusive of less common kinds grown in our nurseries for transplanting. Among nursery-grown plants, the black locust has led not only all other legumes but all other plant species. The Service and its cooperators have planted approximately 100 million locust trees in the past 5 years. Next year about 15 million will be used—only half the yearly average previously planted. The reduced proportion of locust to other trees will afford a better selection of species to meet the ecological requirements of the various sites on which they are to be used. A leguminous vine of great value for erosion control in the Southeast is kudzu (*Pueraria thunbergiana*). Twelve million vines will be transplanted to raw gullies and eroding areas next year.

Soil conservation measures include the use of legumes in crop rotations, strip cropping, pasture improvement, gully and gall-spot revegetation, and the planting of terrace outlet channel margins and field borders. A field border plant that is gaining great favor in the Southeastern States is the introduced perennial *Lespedeza sericea* which controls erosion on unproductive field borders and at the same time furnishes ground nesting cover for wildlife, and turn rows for teams working the field. It is likewise used on the berms of terrace outlet channels where it prevents the Bermuda grass planted on the outlet bottom from spreading to adjacent cultivated areas. It also has successfully stabilized seriously gullied areas.

Native lespedezas likewise show promise of combined usefulness in soil and wildlife conservation; all of them possess the advantage of being perennial. Among them *Lespedeza virginica* would seem a promising plant to do throughout the East what *L. sericea* has done so successfully in the South. It is much like *L. sericea* in habit, grows well on dry, poor soil, and is a good soil improver. Its wildlife record includes use by bobwhite and wild turkey. Other native lespedezas, which vary in habit from prostrate or low species to tall coarse forms, are known to be utilized by wildlife for food, and show inherent soil-preserving tendencies. Last year the Service used 400,000 pounds of lespedeza seed, including native and introduced, annual and perennial species, and produced in the nursery nearly 2 million lespedeza transplants of half a dozen different kinds. Many other legumes promise to contribute to the control of erosion and the benefit of wildlife. On a wide variety of soils and under varying climatic conditions the Soil Conservation Service nurseries are propagating and carefully observing numerous native as well as introduced species to determine their potential value in our program.



IMPROVING FARM WOODLAND FOR WILDLIFE



by *Frank C. Edminster*



WOODLANDS often occupy the most erodible lands on the farm—the steep slopes, rough areas, ravines, and stream-banks—and consequently the way in which they are treated is a matter of considerable importance in soil conservation. If properly managed, the cover of woody vegetation holds the soil in place; but once the woodland is abused it deteriorates and the soil begins to wash away, often destroying other fields as well as the land from which it came. Optimum yield of both the plant and animal products of the woodland depends upon proper management and thereby is the economic justification for this essential erosion-control cover in the farmer's land-use plan.

Any successful plan of management must recognize the ecological nature of a woodland. It consists of a community of organisms of many species of both plants and animals, bound together and surviving by virtue of an intricate network of mutual relationships, many of them as yet little understood.

The animals inhabiting woodlands continually benefit the woodland itself, and game and fur may be harvested as an annual crop while the owner awaits the development of timber. Practically all silvicultural operations affect these animals. It is therefore important that woodland management include practices for the maintenance of wildlife requirements—this in order that a maximum combined crop of woods, wildlife, and other products be provided and the continued healthful survival of the woodland be assured. This requires some knowledge of the particular features which make certain woodlands favorable habitats for wildlife.

A woodland suitable for wildlife must be properly maintained from the standpoints of soil conservation and silviculture. Protection from fire is essential in most woodland types. Exclusion of livestock is vital to erosion control on steep land, and to adequate plant reproduction on almost any land. Since good forestry requires that all trees (except den trees)

should be harvested for their wood products upon reaching their greatest growth of sound wood, the woodland will be an uneven-aged stand, predominantly second growth and immature. This is consistent with good ecology, which requires that any community, to continue to thrive, must be composed of individuals of all ages.

A mixed woods is most favorable for wildlife. A woodland composed of two or more types is superior to one of a single type, and within each type a variety of species generally is desirable. Single-species stands are more subject to insect and disease hazards. At best they furnish but a restricted food supply and a single type of cover to wildlife—far from a balanced diet or satisfactory protection. It is well to maintain a scattering of all species indigenous to the type, if not as crop trees, at least as fillers and for their wildlife values.

The size and arrangement of the types within the woodland also are important. Wildlife is a product of edges—the borders between vegetation types. The first hundred feet into a type is highly productive of wildlife; the second hundred feet is still productive, but less than the first; the third less than the second, and so on. In the Northeast, as a general rule, the width of a single type of woodland should not exceed 600 feet so that no point will be more than 300 feet from an edge.

Another cardinal principle in wildlife management is that all cover and food types needed by a species must exist within the cruising radius of the species. If an animal is so constituted that it will not travel over an area greater in radius than a quarter of a mile, then all its requirements must be provided within that space; otherwise, it cannot occupy the area at all. Thus it is important that all needed types be so interspersed that they are conveniently located with respect to one another.

Woodland management for soil conservation and the production of wood products and wildlife is largely a matter of controlling ecological succession.

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By various cultural practices, the development of the plant association is directed toward what is conceived to be the most desirable composition, quality, density, and arrangement of the stand. In managing a woodland for multiple use, a course of moderation must be pursued. The highest potential development of any one product occasionally must be foregone in favor of others. The plan of management should include principles and practices that will assure a reasonable crop of wildlife along with the wood products.

Every woodland is a separate problem, and must receive individual treatment. From the standpoint of wildlife management, the first step is to analyze the existing situation in terms of food and shelter. The stand then should be handled so that these factors are improved and maintained at the highest level consistent with other objectives.

In stands deficient in shelter, these practices may be employed: (1) Liberation of suppressed conifers and other shelter-producing species; (2) interplanting of conifers in poorly stocked stands, adjacent to food-producing coverts, where protection from grazing is not likely to result in adequate natural seeding; (3) construction of brush piles from cuttings, adjacent to food units; (4) hastening development of potential den trees by girdling.

In stands deficient in food, the following will be beneficial: (1) Liberation of food-producing trees and shrubs, especially adjacent to existing shelter units—a practice which is most effective near the border of the woodland; (2) selective cutting to create small openings adjacent to shelter to admit sunlight to the forest floor and induce germination and fruiting of many food species—a good system of woods roads is helpful in making openings; (3) planting woodland margins to borders of food-producing woody vegetation.

In all cases, emphasis should be placed on proper arrangement of food and shelter. The two should exist in adjacent units and with as much interspersal as possible.

The fact that woodland edges provide the best wildlife habitat should be kept in mind. Emphasis should be given those parts of woodlands within 200 feet of openings. In arranging the cutting blocks in a sizeable woodland, it is often desirable to treat the outer 100- to 200-foot zone as a separate block, with cutting particularly aimed at wildlife habitat improvement. In extensive areas of uniform type, the break-up may be accomplished through differential cutting and the creation of different age-class combinations. Harvesting

of timber may then be accomplished by a long rotation of light cuttings without endangering the soil.

The woodland border normally is an edge between two types, the woodland itself and some open-field type. The amount of desirable "edge" may be doubled by the introduction of a third type—the shrub association—between these two. Low-growing woody plants which furnish wildlife food—fruits, nuts, or seeds—should be used. Such a strip occupies a zone that is often unproductive of field crops and subject to accelerated erosion. Utilization of this strip for border planting is good silviculture in that it affords protection to the woodland from drying and damaging winds and serves to train up the outermost woodland trees.

The width of such a planting may depend on the extent of the unproductive field border, on the land use in the adjacent field, and on the interest of the owner in improving his woodland. Usually from 20 to 30 feet may be devoted to this purpose. Species should be selected and planted to produce a banked growth, the lowest next to the open field and the highest on the woodland side. The low plants may be herbaceous perennials, low shrubs, or vines, and the succeeding rows progressively higher species, with tall shrubs or small trees next to the woodland trees. This sloping-top form of a woodland border serves to direct air currents over the woodland, prevents the formation of another unproductive field border, and provides an abundance of sunlight, so necessary for good seed production, to all the plants.

In woodlands from which the coniferous element has been eliminated, there may be no reasonable probability of natural conifer reproduction. In such instances, where wildlife shelter is markedly deficient and the crown canopy of hardwoods is relatively sparse, interplantings of conifers may be made in clumps under the crown openings. The standard plantation spacing may be followed, and usually only shade-tolerant species should be used. Where the crown openings are fairly large and understory competition is not too severe, less shade-tolerant species may be included.

The composition, quality, and density of the stand may be modified by selective cutting. In these operations, consideration should be given to the needs of wildlife as determined by the initial examination with respect to food and shelter supplies. Each piece of woodland must be studied separately in order to decide which species are to



be favored for the benefit of wildlife. This depends on the kinds of wildlife being encouraged. Usually it is desired to manage more than a single species, and the requirements of all must be blended into a plan. A typical example from the Northeast is described to point out details of woodland management for erosion control and wildlife.



THE wildlife species particularly desired in a certain woodland are ruffed grouse, gray squirrel, and cottontail rabbit, in addition to the song and insectivorous birds. Considering shelter first we find that among the trees present the hemlock is most desirable for the ruffed grouse. The gray squirrel depends primarily upon hollow trees for shelter, hence much emphasis will be given to developing hardwood den trees. Rabbits require marginal thickets in the understory and to supply this need raspberry, arrowwood, hazelnut, yew, and other thicket-forming species will be favored.

Food requirements are considered next. For the grouse several trees furnish buds, mast, or fruit. In this woodland the most important are yellow birch, hop hornbeam, beech, white oak, blue beech, and black cherry. In the understory we find witchhazel, mapleleaf virburnum, and grape. For the gray squirrel, the emphasis is to be primarily on mast producers—in this instance, beech, white and red oaks, and hazelnut. Flowering dogwood also is a valuable squirrel food. The food requirements of the rabbit are not so well known. Raspberry and a number of other shrubs already selected as shelter species, as well as many herbaceous plants, are eaten by rabbits. No additional woody species, therefore, will be selected for this purpose.

Requirements of small birds are largely met by plants already named. However, bayberry and spicebush are added to the list for the food they furnish. Altogether, nine trees and nine shrubs will be favored for the benefit of wildlife in this woodland. Hollow trees for dens will be preserved or developed.

It must be understood that these 18 woody species are not the only valuable plants in the woodland community. Rather, they constitute the group which may be developed most effectively to improve wildlife conditions. Many other plants, both woody and herbaceous, will play their part in a balanced woodland ecology. The example cited is only the one instance, but the principles of selecting wildlife plants are essentially the same in any woodland.

After it is decided which species are to be favored,

cutting is directed toward their encouragement. This sometimes is accomplished by the release of suppressed individuals through removing the competing plants. Some species may be increased by making small openings in the woodland to induce germination of seed on the forest floor. Occasionally planting is necessary to reestablish conifers depleted by lumbering.

Where den inhabiting animals are wanted, hollow trees, or "wolf" trees in the process of becoming hollow, should be left at the minimum rate of two per acre. Girdling sometimes may be used to speed up development of hollows and eliminate dominating foliage.

Improvement of quality in the stand is a matter of selective cutting of individual specimens rather than of species. In woodland management for timber this is done by removing the defective trees, thereby providing space for other trees of better form. Wildlife plants likewise may sometimes be inferior because of unhealthy condition, in which case they should be removed. But many times the tree valuable to wildlife is retarded for want of light. In such an instance the remedy is to remove enough of the competing stems to provide light for the retarded tree, with due consideration, of course, to the value of the competing trees. Other factors being equal, individuals of seedling origin should be favored over coppice or sucker growth.

Plants furnishing browse become unavailable if they grow too high. By cutting, many species may be made to regain this value through sprout growth.

A crown cover of at least 60 percent—that is, three-fifths of the ground shaded by tree foliage—should be maintained in all cases. Even if inferior in quality, a 60-percent crown should be maintained to provide adequate erosion control and to serve as a nurse crop for more valuable species. Living trees should be cut only to release more desirable individuals, to improve seeding and germination conditions, to decrease overstocking, or to remove plants that are seriously diseased.

The forest canopy should include, per acre, at least 15 trees of wildlife food value. This amounts to 5 percent to 10 percent of full normal stocking. In the outer portion of the woodland, the percentage of wildlife food trees should be much higher, even to the entire stand, provided enough species are present in adequate numbers and that a reasonable part of them will also furnish harvestable wood products.

Density of the understory is controlled largely by crown density. The crown should be open enough to permit a good understory of shrubs and young trees,

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WILDLIFE AND THE RANGE

by *Lawrence V. Compton*¹



THE importance of the range as the natural environment of western wildlife has been generally overlooked. This is true partly because many of the principles of wildlife management were developed in the eastern States where cultivated farm lands are the rule. Although considerable wildlife research has been done in the western States, relatively little attention has been given to wildlife management.

To those who have lived in the West or are familiar with that extensive country, the range is a fairly definite concept. To them, it usually evokes the mental picture of rolling grasslands, shrub-covered hillsides, open woodlands, and magnificent forests, with tall mountains in the background, all surmounted by a deep blue sky.

The range is that area west of the one hundredth meridian, supporting primarily native forage plants and used mainly for the grazing of domestic livestock. According to the best estimate it aggregates about 728,000,000 acres out of the total 975,000,000 west of the one hundredth meridian. This means that the range covers approximately 40 percent of the United States. It is a varied land of plains, plateaus, valleys, and mountains. It is clothed sparsely in some places, abundantly in others, with grasses, shrubs, and trees, and the climate is essentially semiarid in type. Because of the limitations imposed by topography, soil, water, and climate, only a small portion can be used for agricultural pursuits other than grazing.

Western wildlife, with the exception of a few introduced forms, consists of species adapted to existence in this type of habitat. For the most part, they reached their maximum numbers under natural range conditions and they continue today to be dependent upon the range rather than upon the limited cultivated lands of the West for much or all of their food and cover.

Farming is practiced on about 4 percent of the land of the western States. This relatively small amount of cultivation has little, if any, beneficial effect upon the general population of game animals. In fact, by the high human utilization of water, the clearing of brushy bottomlands, the reduction of winter foraging ground, and the introduction of disease and domestic

predators, it has had a definite limiting effect upon wildlife. These detrimental factors have greatly offset the beneficial ones that ordinarily accompany western cultivation, such as the introduction of weeds and cultivated grains, and the presence of irrigated fields and brushy ditch banks. The ring-necked pheasant and Hungarian partridge and the eastern bobwhite have been introduced in many places and have become established mainly in the agricultural lands, but these birds have not done well on the open range. While there is some evidence that nongame species of wildlife have increased with cultivation, the beneficial and detrimental factors seemingly are balanced when we consider the amount of brushland cleared and marshland drained.

With these exceptions, the wildlife of the West is range wildlife. Elk, deer, and antelope are browse-eating species; they find their food on the range and enter cultivated lands only when pressed by hunger. Turkey and grouse live in woodland and seldom have an opportunity to venture into cultivated fields. Sage hens like alfalfa, but they must have sagebrush in order to thrive, and when the sagebrush disappears, so do they. Rasmussen and Griner have shown that 77.5 percent of the food of the adult sage hen consists of two species of sagebrush, and that their nests usually are protected by these shrubs and are never a great distance from them. The western species of quail, particularly the valley and Gambel's quail, are often abundant in irrigated valleys, but they regularly forage on to the adjoining range land and are dependent upon it for a great part of their food. Gorsuch considers the typical habitat of Gambel's quail as the brush type where shrubs afford needed shelter and where food also is plentiful. This is not a habitat ordinarily associated with cultivation. It is the range, not the farm, that furnishes nesting and resting places for migratory waterfowl. And so it is with almost all western wildlife—its home is the range, and in spite of occasional green fields, the range continues to be its main reliance.

The serious decline of western wildlife and of the range have gone hand in hand. Bison have been reduced from millions to a few thousands, and these lead a semidomestic life behind fences. Nelson placed

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the original population of the prong-horned antelope at not less than thirty to forty million individuals. The present population is estimated to be 65,000. The bighorn sheep and the mountain goat have almost disappeared and it is generally felt that the few that remain are not holding their own. Under pioneer conditions, the sage hen was found in at least 14 western States and was considered the leading game bird in 9 of these, but its range has been restricted and its numbers lowered until during the past 5 years it was considered the leading game bird in only Montana, Wyoming, Idaho, and Nevada. In 1937 the season was closed in Wyoming, and greatly restricted seasons were inaugurated in Idaho and Nevada. Big-game mammals, upland game birds, waterfowl, and furbearers have all been greatly reduced in numbers, and this decline, in spite of increased restrictive legislation, continues today.

The destruction of the range itself has been no less severe. Throughout its 728 million acres, deterioration has been almost universal. The range has been depleted approximately 52 percent from its virgin condition, and here depletion is used in the sense of reduction in grazing capacity for domestic livestock. This means that the range once was capable of supporting 22.5 million animal units, but that now it can carry only 10.8 million. This depletion consists of the disappearance, largely or altogether, from many parts of the range of valuable forage plants; the replacement of perennial grasses by less nutritious annual grasses and weeds; and the marked reduction in density of the better forage plants. This decrease in forage has been accompanied by accelerated erosion, destruction of valuable watersheds, siltation of reservoirs, loss of stock waters, and lowering of water tables. The primary cause of the destruction has been overstocking.

Various explanations have been advanced for the disappearance of western wildlife. Although introduced diseases, abnormal weather, and predators may have contributed after the decline had reached critical proportions, it must be recognized that the primary causes of the depletion of wildlife have been excessive hunting and trapping and the destruction of the range environment.

The importance of hunting and trapping in effecting the initial depletion of western wildlife should not be underestimated. This was a systematic, big-scale business conducted for profit, and its effect upon the population of game and furbearing animals was devastating. Over the western United States as a whole, wildlife even yet has not recovered from the trapping,

market hunting, and general hunting that occurred during pioneer times. Market hunting has now been fairly well eliminated; but bag limits, length of season, and locale of hunting and trapping are by no means regulated according to the harvestable crop.

Meantime, the white man, with his insatiable desire for more land and his frequent misuse of what he has, has succeeded in destroying not only the environment of wildlife, but in many places his own as well. Overgrazing and submarginal farming have needlessly reduced the vegetative cover. Domestic and industrial requirements, irrigation, and stock watering have lessened and, in some places, eliminated water for wildlife. Farming has taken food and cover from the valleys. Drainage has destroyed the waterfowl breeding grounds; and human occupation has forced upland wildlife, particularly big-game mammals, to winter on the summer range.

The requirements of range wildlife are adequate food, cover, and water, on both winter and summer range. The provision of these necessities, coupled with effective regulation of hunting according to annual production, will make possible the management of wildlife as a harvestable product of the land. It is to the restoration of environment that the efforts of the Soil Conservation Service are directed; the regulation of hunting is a responsibility of the States and the landowners.

The biologist works hand in hand with the range manager in reconstructing the range so that the needs of both domestic livestock and wildlife will be met and soil and moisture conservation problems solved. Wildlife food and cover are increased through the regulation of grazing—by establishing proper livestock numbers, fencing, and water development. This permits better distribution of livestock and lighter utilization of forage, allows the production of a correspondingly more effective soil cover, more dependable forage supplies from year to year, and more abundant vegetation for the use of wildlife.

The retirement of submarginal grazing lands and areas of critical erosion hazard from livestock usage serves to restore the normal balance between winter and summer range for wildlife and curbs some of the most serious cases of accelerated erosion.

Development of stock water is potentially either beneficial or harmful to wildlife, depending on how the work is done. A spring that is cased and led to a trough is often lost to all except the largest animals and frequently is a death trap for the smaller ones. If a ramp or steps are placed in the trough, however, the spring continues to be safely available to all

wildlife. The life of surface reservoirs may be greatly lengthened by planting aquatic vegetation along their margins, establishing desilting plots on the waterways, and fencing all but the approaches for stock. This procedure not only ensures a longer life for the reservoir, but it makes valuable wildlife habitat out of the otherwise barren and trampled area that usually surrounds stock watering places.

Stream bottoms are important in the wildlife environment. Some species are restricted to such habitats while others are dependent upon them to some extent for food, cover, and water. The fencing and planting of stream bottoms is at once an important erosion-control and wildlife-management measure. The restriction of grazing combined with the planting of carefully selected plant species results in rapid vegetative recovery, reduction of stream velocity and of erosion, and greatly improved environment for wildlife.

Experience has shown that these conservation practices do increase wildlife populations. Becenti's Lake, 8 miles northeast of Crown Point, N. Mex., is a stock water reservoir of 30 surface acres. The reservoir and a small area surrounding and above it were fenced as a desilting plot, stock was excluded, and small amounts of woody and aquatic vegetation were planted. Prior to construction of the dam, the valley bottom in which it was built was badly eroded. The dam reduced gully erosion below the reservoir and filled many of the gullies above it. The fenced desilting plot brought a marked increase in vegetation which caused deposition of much of the silt before it could reach the reservoir, although the countryside outside the fenced area continued to be overgrazed and remained in much the same condition as it was at the time the plot was fenced.

Three years after the establishment of the desilting area, Gale Monson, Soil Conservation Service biologist, made a count of the wildlife that could be found on it and on a comparable area (but without a pond) outside. In the desilting plot 137 individuals of 11 species of native birds were counted; in the outside plot, 76 individuals of 3 species. Of the birds found inside the desilting plot, the occurrence of 5 species and 23 individuals was attributable to the availability of water. The presence or increased numbers of other species was directly attributable to the increased vegetation.

The Steamboat Demonstration Area on the Navajo Indian Reservation provides another example of effective wildlife habitat improvement and soil and moisture conservation. Here proper grazing practices were prescribed and maintained, fences were built to control

the distribution of livestock, woody plants of value to wildlife were used for erosion control, and structural treatments were employed to stop soil wash and increase the availability of moisture for forage production. A wildlife census of plots inside the area and of comparable plots outside showed that the number of individuals was doubled within the demonstration area, although the number of species remained the same.

It must be recognized that wildlife has both tangible and intangible values to human society. It has been estimated that in the range area, the expenditures by sportsmen for equipment, travel, food, and other necessities for hunting in the season or 1930-31, were \$40,300,000; tourist expenditures on national forests within the range area were \$155,000,000; and the annual value of meat and fur in the area is placed at \$87,250,000. The expenditures by the sportsmen were directly due to the presence or supposed presence of wildlife. It is impossible to estimate how much of the tourists' money was spent for the privilege of just looking at wild creatures with no thought of shooting them; it must be an appreciable amount, however, for the appeal of animals is universal. The monetary value placed upon wildlife is very great, but this represents only the cost of outfitting and getting into position to appreciate wildlife; it cannot represent the human well-being brought through recreation and purely esthetic pleasure. It is obvious that wildlife is a natural resource that plays a definite and valuable part in the economic and social life of the West. These assets make it desirable that wildlife be managed as one of our valuable renewable resources.

Good administration will not permit the development of conflicting conservation programs on public and private lands, and good economics will not permit the use of any land without continual reference to what is the major use of land today; namely, agriculture. A conservation program which leaves out of consideration the owners and users of more than half our total land area does not make much sense. The national program of land use which has been taking shape during recent years in the Department of Agriculture begins with this major use of the land and seeks continuous integration of this use with all others . . . wildlife conservation will continue to hold its proper place in this program.—Henry A. Wallace.

Muskrats help to pay the taxes on a small 66-acre farm in southern Michigan, where about \$75 is received each year from the sale of muskrat pelts.



1. Where shrubs provide nesting cover and food.
2. Where natural habitats are preserved.
3. Where ground-nesting species find grassy cover.
4. Where field borders supply food near woodlands.
5. Where fence rows provide travel lanes and refuge cover.
6. Where woodland understory is well developed.
7. Where strip crops vary vegetation.
8. Where banks are protected and streams run clear.

WILDLIFE





3



7



LIVES HERE

9. Where food plants meet cover plants.
10. Where vegetation protects rough slopes in fields.
11. Where the western range is grazed within its carrying capacity.
12. Where the desert is lightly used.
13. Where marshes are undisturbed.
14. Where grassland gullies are fenced.
15. Where there is good interspersion of fields and woodland.
16. Where pond shores are vegetated.



11



RODENTS AND SOIL CONSERVATION

By Richard M. Bond¹ and Adrey E. Borell²

IN THE execution of a program of soil and moisture conservation in the West, we are immediately confronted with the problem of what to do about rodents. Some people tell us that our program can be nothing but a failure if we do not control these animals; that they will break our dams, that they will increase erosion, and that they will not permit grass to return to the overgrazed range. Others tell us that rodents are beneficial agents in the building of soil; that they cannot do appreciable damage to well-made dams; that their presence in large numbers is a result of overgrazing, and that the operation of our program in itself should do much to reduce rodent populations.

These are diametrically opposed views; it can hardly be possible that both are correct. But it is important that we know which is correct if we would formulate our program on a biologically sound basis. The Soil Conservation Service was set up specifically to effectuate a national program for the conservation of soil and moisture. The keynote of this program, as expressed by the Congress, is the control of erosion. Therefore, if the control of rodents has no important bearing upon the control of erosion, we should dismiss the idea and direct our thinking towards more promising activities. On the other hand, if rodent control does have a legitimate place in our program we should have definite proof of that fact, and then utilize rodent control as we would any other acceptable erosion-control measure.

Sound business management also demands that we ascertain which of these opposing views is correct. Such rodent control as we have done has proved expensive; in fact, its per-acre cost has been among the highest for land treatments on the range. Hence we cannot afford to conduct large-scale rodent control operations without being sure of our ground.

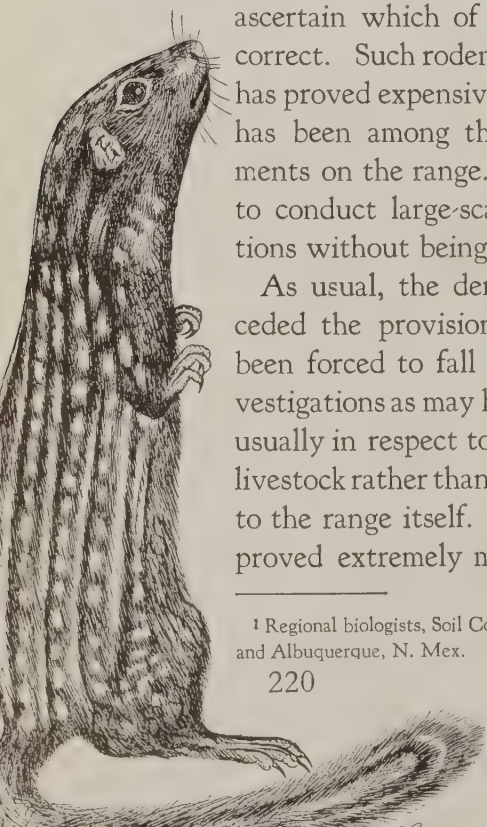
As usual, the demand for action has preceded the provision for research. We have been forced to fall back on such sporadic investigations as may have been made by others, usually in respect to rodent competition with livestock rather than to the relations of rodents to the range itself. The available data have proved extremely meager, inconclusive even

in respect to the influences studied, and wholly unsatisfactory from a soil conservation viewpoint.

A recent bibliography lists 8,229 important books, articles, and other publications dealing with the western range. Of these 216 come under the heading "Control of Range-Destroying Rodents." From a perusal of these papers it becomes obvious that the majority of the authors regard rodents in rather a baleful light. Where rodents invade cropland, and eat corn and alfalfa, or girdle fruit trees, there is excellent reason for such an attitude, but it is surprising to learn how few people differentiate between what rodents may do on cropland and their activities on the range where conditions—and therefore effects—may be quite different. It is surprising also to discover how few of the authors seem to realize that an animal, even though a rodent, may possibly do more than one thing; in other words, that a cause can have more than one effect, and an effect more than one cause. The number of scientific studies of just what it is that rodents do to the land, or just what any one kind of rodent does to a given piece of land, may be numbered on the fingers of one hand. No careful study has been made of *all* the effects of the rodents on a given area, and no study at all has been made of the bearing that rodents may have on soil and water conservation.

Vegetation is our first defense against erosion. The presence or absence of vegetation depends upon many factors, important among which are soil conditions and plant utilization. What part do rodents play in the development and application of these factors? There is no question that certain rodents will eat plants that a cow or a sheep would otherwise consume; but we are not justified in assuming that plant destruction is the only thing accomplished by these rodents, unless this is demonstrated by thorough investigations. Such investigations have not been made, though they are needed badly, and have been needed for many years. True, there are some suggestive items in the literature, but most of these are in the nature of essays by scientists, rather than scientific studies. Curiously enough, the more profound investigations seem to have turned up bits of information favorable to the rodents. Studies on desert soils in Arizona by Greene, Reynard, and Murphy have shown that each banner-tailed kangaroo rat adds to the soil plant nutrients, espe-

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cially nitrates, that would cost about 30 cents to apply in the form of commercial fertilizer. The kangaroo rats also bring about aeration and increased water percolation, due to burrowing, and are responsible for a considerable increase in organic content because of the plants and other material brought into their burrows. The actual water-holding capacity of the soil is also considerably increased, largely by the mixing action of their digging. Desert wood rats were shown to have the same effects, but to a less marked degree since their burrows are less extensive.

PERHAPS the most vexing—by all odds the most persistent—problem of our western biologists revolves about rodents. Were the problem merely biologic, it would still be serious enough, for while rodents are the most numerous of all mammals, we know but little of their ecology. The biologic phases of the problem, however, are considerably complicated by economic considerations, and sometimes both are overshadowed by psychologic factors.

In its simplest terms the problem is this: Should funds appropriated for soil conservation be used to control rodents? There are two schools of thought on this subject, even within the Service, but decision as to policy rests with the biological staff. Because the biologists consider the price of control measures high in proportion to benefits that are transient and of doubtful value to soil conservation, the question has been much debated.

Unfortunately the whole controversy has arisen over a symptom and has diverted from the disease itself the attention needed to effect a cure. That overstocking by domestic animals lies at the root of the real ills of the western range is beyond any question. Yet it often happens that a ranchman, when asked to cut his livestock numbers in the interest of soil conservation, blames the rodents for the condition of his range and demands rodent control as the price of stock reduction. The fact that it is not the policy of the Service to buy acceptance of its program, or to spend money where the erosion-control justification is not clear, does not impress a man who believes that rodents consume as much forage as does his stock, and who is anxious to find arguments against reduction. In fact, overemphasis on damage of rodents has consistently hindered the progress of our range program.

Moreover, the Biological Survey is prepared to help ranchmen with their rodent problems. It is entirely right and proper for the Biological Survey to demonstrate methods of rodent control, and to carry out con-

Grinnell, in discussing the burrowing rodents of California, postulates that the native plant cover is the most important single factor in conserving soil and water, and then explains the relationships between the vegetation and the native animals. About one-fourth of all the kinds of mammals in the State are burrowing rodents, and these comprise at least one-half of the total mammal population. The most widespread and abundant are the pocket gophers. Together with Storer, Grinnell calculates that the gophers in Yosemite National Park annually move an average

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trol operations when the Congress has specifically appropriated funds for that purpose. It must be clearly understood, however, by our own staff and by our cooperators that such rodent control as we may do, or require to be done, must be necessary for the attainment of the Soil Conservation Service objectives—soil and water conservation.

So much pressure has been brought on the Service to do rodent control that I have asked our two regional biologists most concerned, Messrs. Bond and Borell, to discuss briefly the present state of our knowledge concerning rodent-soils relations, and to point out the type of information we must possess before we can properly evaluate those relations in terms of soil conservation. I greatly hope their paper may help to stimulate the research that is so badly needed, and may clarify the position the Service must maintain until the biologic aspects of the problem are solved.

WHAT TO DO

C. B. MANIFOLD,
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Division of
Conservation Operations.



of 3.6 tons of earth per square mile from underground up to the surface, and as a result the formation of soil is hastened by the burrows which carry air, water, and dissolved matter to the subsoil. The subsoil is broken up and brought to the surface where it is still more rapidly weathered; the increased soil porosity makes for better moisture retention; and organic litter on the ground is buried by the dirt thrown out by the gophers and is thus incorporated into the soil. These activities of burrowing rodents on ground that is not overgrazed all tend to prevent erosion.

Most of what is known, or rather, suspected, of animal relations to soils has been summarized by Walter P. Taylor. He concludes that there seems to be little or no evidence of a critical character that rodents under natural conditions promote soil erosion. Later, Van Dersal, on a quest much like our own, brought Taylor's summary up to date, and summarized a number of papers that were not accessible to Taylor. Van Dersal condenses his study of the literature as follows:

To summarize, careful analysis of the studies so far made of the effect of animals on soils insofar as the conservation of the soil is concerned, leads definitely to these conclusions:

1. Animals that by trampling or other means compact the surface soil tend to increase run-off and, consequently, intensify any erosion hazard that may be present.
2. Animals that burrow into the soil and thus increase its porosity tend to reduce run-off and thereby decrease the erosion hazard. The latter conclusion is not invalidated by the rare, isolated instances, where through combinations of circumstances often directly traceable to the intervention of man, rodent burrows have been shown to be primary causes of erosion.
3. In general, animal presence and activities in soils materially assist in the mixing, loosening, aeration, drainage, and fertilization of soils, thereby permitting the increase of plant life, and by a combination of all these factors promote the conservation of soils.

We hear much regarding rodent damage to earthen water-controlling structures. Many people are convinced that rodent control is utterly essential to maintenance of such earth structures; others are equally positive that any dike, dam, or reservoir that requires rodent control for its preservation is not properly constructed, and is doomed to a short life even if no rodents are present. Here again, as with other phases of the problem of relationship of rodents to soil and moisture conservation, our data are inadequate regarding what kinds of rodents damage what kinds of structures, the nature and seriousness of this damage, the extent to which alterations in design of structures may reduce or eliminate rodent damage, the actual effectiveness of rodent control in relation to structure protection, and the cost of repairing structures in

comparison with the cost of frequent rodent control. Much more information is necessary before we can justify extensive rodent control for the protection of structures.

As we go over the literature it appears at first sight that rodents do both a great deal of harm and a great deal of good, that they cause and prevent erosion, that they should be at once encouraged and exterminated. This rather startling conclusion may mean that rodents in some areas are doing more harm than good, and in other places more good than harm; or it may mean that under some conditions the harm is easier to recognize than under others—that the good is seldom obvious, even when very real.

It is clear enough, however, that the relations of burrowing rodents to soil and moisture conservation constitute a very complex problem. Consideration must be given to all the effects on plant cover, and to the effects of this cover on erosion as well as to the direct effects of the rodents on the soil. If we are to know just what are the relationships of rodents to the conservation of soil and moisture, we must be able to answer many searching questions.

For example, to what extent do rodents actually compete with stock for range forage? Because of many complicating factors, usually neglected, competition should be measured in terms of livestock gains or days of grazing, and not by weighing or counting plants. Also it must be determined for several rodent species, with different kinds of livestock, in various climates, on different types of soil and vegetation, in wet years and dry, and throughout a considerable period of time.

How much good do the different rodents perform, under different conditions, in improving plant growth by aerating and mixing the soil, and by adding plant nutrients to it? Under what conditions and to what extent do these beneficial effects counterbalance the competition for forage?

Under what conditions do what rodents decrease run-off and add water to the soil, and how much? How much is this effect counterbalanced by soil denudation and packing by certain kinds of rodents? Under what conditions do the various rodents increase soil erosion by their burrows, and how much of this effect is counterbalanced by decreasing run-off?

Obviously, the most important answers will be those dealing with land that is conservatively used. Unhappily much of the West is so overgrazed that the domestic stock is ruining the vegetation, and causing soil erosion. Rodent effects under such conditions may easily be very unlike those under proper land use, and can hardly be important. Unless the numbers of livestock are reduced to the safe carrying capacity of

the range, the vegetation, and even the land itself, is doomed whether there are rodents competing with the stock or not.

Getting answers of any value to these questions will take time. It seems likely that an improvement in the range could be noted the first year after rodents are extirpated, as the soil will still be mixed, plowed, and porous, and the added plant nutrients will not have been exhausted. It may take many seasons for the soil to pack down so that all the rodent effects are lost, and it is only then that we should be able to tell whether rodent eradication was good or bad for the land. Not only must these studies be made over a long period, but they must be made on large areas. The smaller the area studied, the easier it is to determine exactly what happens to that particular plot of ground, but the more difficult it is to simulate average conditions on the open range, and the more dangerous it becomes to make sweeping generalities from the findings.

General observations and thoughtful inferences, though of the greatest value, cannot take the place of long-time, well planned, carefully thought out, and accurately executed scientific study, and until such work is actually effected, we cannot know whether or not the control of rodents will aid the control of erosion. Clearly, then, caution in the expenditure of soil-conservation funds for rodent control is definitely indicated.

HEDGES CONSERVE SOIL AND WILDLIFE

(Continued from p. 209)

our "hedge rows" as typified in sections of the Midwest by rows of Osage-orange trees. Generally they are 5 or 6 feet high, growing in dense thicket, and often are given the care we might give to ornamental hedges in connection with landscaping home grounds. Less trimming is done in France, but the hedges generally are not tall and consequently they do not exert a depressing effect on the yield of adjoining crops. Hedges are frequently used as fences to control live-stock, thus eliminating the expense for fencing materials.

While making the tour I had little opportunity to study the species of trees and shrubs used for hedges, although it was apparent that the hawthorn is commonly used. Hazel, privet, holly, and even maple, elm, and ash were growing in hedges.

The use of hedges has been a subject of much discussion in this country. There are many people who advocate their use and likewise many who oppose it. In general, it may be said that hedges, as properly used

for contour planting on slopes—as fences, for erosion control, and for wildlife cover—are practically nonexistent in this country, and I believe that an opportunity exists for encouraging such plantings. Certainly, on long slopes where strip cropping will not control erosion and where terracing is impractical because of lack of proper outlet facilities, contour hedges should be tried. Undoubtedly the result will be the development of bench terraces, but there are many situations in this country where apparently there is no other alternative for the continued production of crops.

The value of trees planted in rows, as windbreaks, for the prevention of wind erosion and crop damage, is well recognized in several localities in the Western States. In the Salinas River Valley of southern California, rows of eucalyptus effectively protect citrus and other fruits, and also truck crops grown under irrigation, from wind erosion and actual wind damage. The Lombardy poplar is used extensively in row plantings for wind protection along the Columbia River above The Dalles, and also in many irrigated sections of Utah. The practicability and effectiveness of the practice depends on local conditions, including soil type, abundance of moisture, wind velocity, use of proper tree and shrub species, and many other factors.

It has been stated that hedges harbor insects that attack crops. This may be true in some instances; but it must be admitted that they furnish protection for birds and predacious insects that feed on many insect pests. It seems to me that the planting of hedges within the limits of practicability and common sense would be a step toward restoring nature's balance on agricultural lands.

IMPROVING FARM WOODLAND

(Continued from p. 214)

yet not so open that the undergrowth becomes rank over large areas. A density of 60 percent to 80 percent usually yields an understory of desirable spacing.

Where shelter of a natural type is inadequate, some of the slash from cutting operations may be piled. This is always beneficial where rabbits are especially desired.

Brush piles should be large and loosely constructed. Where possible the brush should be piled on a stump or other object in order to ensure looseness at the bottom. In piling, the brush should be thrown at random rather than evenly, with the coarser limbs at the bottom. About 12 feet in diameter and 8 feet in height is a good size, and two to four such piles per acre is a good spacing, depending on the need for additional shelter. Other slash should be lopped and scattered.

PUTTING ERODED FIELD BORDERS TO GOOD USE

By Verne E. Davison¹



CTING on the well-known maxim, "Wildlife is a product of edges," biologists of the Service have developed methods of vegetating field borders. It is hoped that crops and woodlands at last can be made to live together as good neighbors, with benefit to farm wildlife, in those parts of the country where farms once were carved out of the primeval forest. The relation of woods to adjacent cultivated fields is commonly an unhappy one in the Southeastern States in particular, and in other sections where pines, oaks, sassafras, persimmon, blackberries, and numerous other woody plants stand ever ready to reclaim the lands wrested from them by the ax and the plow.

A farmer must resist this encroachment on lands profitable for field crops. But, despite his ability to prevent the growth of new seedlings, the roots of maturing trees will draw plant food and moisture from beneath the field border and seriously curtail the growth of his crops. Here lies a zone of transition from open field to dense woods, where neither commercial crops nor forest products can be grown successfully. The soil cover becomes thinner here than anywhere else in the field—soil removal is

considerably hastened where the border catches the water from the ends of several rows during heavy rains.

Yet it is possible for modified field and woodland vegetation to meet harmoniously at a midway boundary. It is in such places, where the edges of herbaceous and shrubby cover adjoin, that rabbits, quail, mockingbirds, brown thrashers, and other familiar wild animals of the farm prefer to live. Frequently, enough fertilizer and seed are wasted on field margins to pay for establishing cover that would effectively protect the soil and provide almost ideal wildlife habitat.

To gain a clearer conception of this problem a study was made recently of the extent of erosion and loss in crop yields, due to woodland competition, in 100 erosion-control demonstration and C. C. C. camp areas in the Southeastern States. More than 3,500 field borders—principally around fields of tobacco, cotton, corn, and wheat, but including a few fields of lespedeza, cowpeas, and peanuts—were examined. For each, the distances from the edge to points where crop production was estimated to be 25, 50, 75, and 100 percent of the unaffected field were recorded. Other features recorded were soil type, slope, degree of erosion, kind and height of trees, kind of crop, and direction of the field boundary.

These studies indicated that the height and, to a lesser extent, the kind of trees along field edges are the most important factors influencing the width of non-productive borders. The other factors studied had little effect on the extent of injury to crops. For an average distance of 33 feet from the edges, fields adjacent to all kinds and heights of woodlands produced less than 50 percent of the normal crop. Strips approximately 12 feet wide nearest the trees were uncultivated, although the distance varied.

Some hardwoods, particularly oaks, exert a more pronounced effect on field crops than do pines. In general, woods up to 25 feet in height affect 20 to 27 feet of the field edge; woods 25 to 50 feet in height influence a border of 27 to 35 feet; while those more than 50 feet high extend their competition to a distance of 35 to 45 feet. Greater extremes were found both with the taller and lower woodlands.

The nonproductive border down the slope from a



Where woodland adjoins cultivated land, there is an area between, on which it is impossible to produce profitable cultivated crops.

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woodland is likely to be relatively wider than that above a woodland; this is because the silt and moisture deposited from the field up the slope compensate in part for the moisture used by the tree roots.

These facts offer some guidance in the determination of widths and design of field border plantings to be used with different types of woodlands. In discussing the intervening strips, however, it is well to differentiate between woodland borders and field borders. "Woodland border" refers to the edge of a woodland which is planted or allowed to grow up to shrubs. Its value to wildlife is well known.

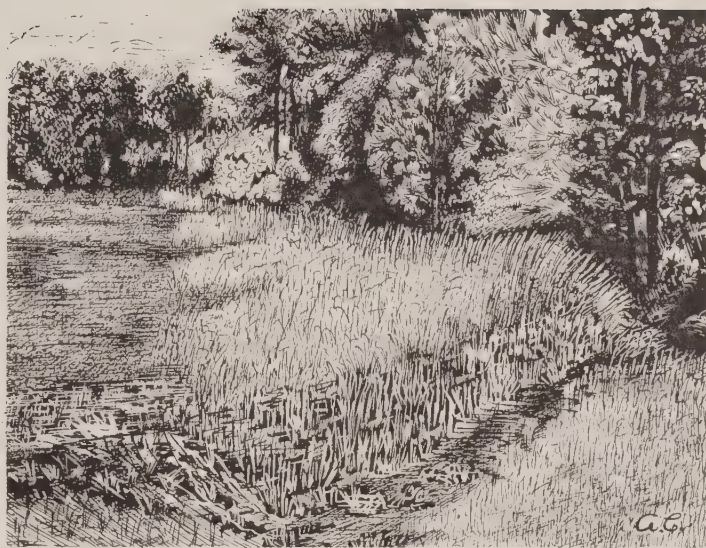
New plantings of forest trees were formerly brought to the very edge of land suitable for cultivation. It is now recognized that this practice was equivalent to encroachment on to the cropland itself, as root systems extend to distances of 25 feet or more before the planted trees produce any harvestable crop. It is therefore logical to use shrubs instead of trees for the outer portions of plantations abutting on cropland. Two rows of shrubs spaced 6 by 6 feet are recommended as a minimum. If the wood is for growth to sawlog size, it is advisable to increase the shrub border to 3 or 4 rows.

"Field border" refers to the margin of a field where a herbaceous strip is established for wildlife food and cover and for the protection of the soil. This border must be designed to permit such measures as mowing, cutting, plowing, or disking, so that there will be no further encroachment of woody vegetation on the field.

If the border is crosswise to the direction of cultivation, whether it adjoins a woodland or not, the cover must be sturdy enough to withstand trampling by animals and the turning of machinery during cultivation. It must also provide a vegetated outlet through which run-off water from the individual rows may be guided to a safe place of disposal.

For convenient maintenance with farm machinery, permanent field borders should be uniform in width and fitted to the field rather than to adjacent woods or waste areas. To accomplish its full purpose, the strip must continue the entire length of the problem area. The edge next to the field should reach the point where average crop production is not satisfactory. A width of 10 to 20 feet is recommended for turn-row, water disposal, and wildlife food purposes. Woodland or gullied areas on the edge away from the field are considered separately. A shrub border to a woodland usually fits closely against the field border so that both become wildlife improvements, each supplementing the other.

On field borders to be used as turn rows, a perennial legume, *Lespedeza sericea*, has demonstrated its value



Where edges of herbaceous and woody vegetation meet is where rabbits, quail, thrashers, and other wild birds and animals of the farm prefer to live.

as a dependable erosion-control plant. For borders adjoining woods, it is particularly reliable because of its tolerance to shade and its deep roots which adequately compete with tree roots for soil moisture. *Lespedeza sericea* is seeded following a rain, between February 15 and May 30, at the rate of 15 pounds per acre on well-prepared soil which has been rolled or allowed to settle. An annual lespedeza, browntop millet, or Sudan grass is sometimes added to furnish temporary ground cover. On sites where more than 75 percent of the topsoil has been removed, a light covering of pine boughs, grain straw, or other similar material may be used to supply this protection.

If the border is parallel to the direction of crop rows, and therefore is not needed as a turn-row or water disposal channel, partridge peas, annual lespedezas, or browntop millet may be used alone.

Maintenance of field borders is necessary to retard the invasion of plants such as broomsedge, shrubs, and trees. Each of the annuals mentioned above will reseed itself and remain the predominant plant if plowed or disked as unwanted species appear. Perennial herbaceous borders may be maintained with the ax, mowing machine, disk, or plow. Cutting of larger trees in the woodland border is sometimes necessary to prevent encroachment into the field and to release shrubs for more abundant food production.

A larger variety of plants adaptable to field borders is needed for a greater contribution to the welfare of wildlife, and for this purpose several native species are being studied in nursery and field trials. Meanwhile it is advisable to depend upon the proved lespedezas and to determine definitely the best methods of maintaining them.

CASH IN THE RANCHER'S POCKET

By Homer G. Towns¹

BOTH by legislative declaration and by existing public sentiment, wildlife belongs to the people of the State. Although wildlife is produced on private lands, legally there are attached to it no private rights. Nevertheless, in some sections of Texas the traditional system of free hunting has given place to one by which the landowner may be remunerated for the game raised on his property. Though without rights of ownership, in the game itself, the landowner who protects wildlife, and controls ingress to the land occupied by it, is now conceded to have the right to charge the hunter for the privilege of shooting over his holdings.

The new system has been in operation long enough (8 to 15 years) and on a scale large enough, and has met with sufficient success, to be worthy of consideration by all interested in the restoration of upland game. Some ideas of the acreage and cash involved, in at least one part of Texas, may be gained from the following list of 1938 hunting leases courteously supplied by the Kerrville Chamber of Commerce:

1. Dan Auld; 3,300 acres; 20 deer and 30 turkeys allowed for \$1,000 cash.
2. Albert Kramer; 2,332 acres; leased to 8 hunters for \$500 per annum.
3. Pat Rogers; 700 acres; leased to 3 hunters for \$150 per annum.
4. Gay Sieker; 1,000 acres; leased to 5 hunters for \$150 per annum.
5. Johnson Ranch; 3,000 acres; leased for \$1,000 per annum.
6. Live Oak Ranch; 5,000 acres; 20 deer and 30 turkeys allowed per annum; leased for 5 years for \$10,000 cash in advance.
7. Mrs. A. T. Whitstone; 3,000 acres; leased to 10 hunters for \$325 per annum.
8. Ruth Griffin; 960 acres; leased to 2 hunters for \$200 per annum.

In discussing these shooting preserves several points should be considered. In the first place, the landowners have learned that sportsmen are willing to pay for the privilege of hunting on lands where some effort is being made to maintain wildlife populations. Second, apparently it is only where sportsmen pay for the

privilege of hunting that there are satisfactory farmer-sportsman relationships in this section of the country. The ranchers receive sufficient returns to justify definite efforts toward game restoration, and the sportsmen are happy to pay the price because they know that game is to be had on these ranches.

A third point concerns the fact that the landowners have learned through experience that deer and turkey populations cannot be maintained on heavily overgrazed ranges. W. O. Harwell, manager of the Kerrville Chamber of Commerce, writes that "wise grazing practices ensure a more bountiful supply of game. We know of many instances where hunters have gone out to look over land offered for lease and then refused even to bother with making a detailed examination of the ranch when they saw how closely the grass was grazed."

The fourth point for consideration concerns rigid control of hunting. The owners have learned that such control is necessary to maintain deer and turkey populations. This principle is demonstrated by the records of the Texas Game Fish and Oyster Commission which show that those ranchers who designate the number of deer and turkey to be taken each season are those whose leases are most in demand and those upon whose lands the most deer and turkey are being killed. According to the commission's report for 1936-37, there have been shooting preserves in west Texas for the past 12 years; and in five of the counties, landowners, as shooting preserve managers, have maintained rigid protection of their game and these counties have produced one-half the kill. This is the record today with over 6,700,000 acres in shooting preserves in about 70 counties. The ratio was the same 7 years ago when there were 2½ million acres in preserves in 34 counties. The ratio has remained constant through the intervening years.

These banner counties now have an annual harvest of over 4,000 bucks on about 1,000,000 acres. If other counties get down to business in the same way, the total harvest eventually should be 25,000 bucks from the shooting preserves instead of 7,683 which was the total for the past season.

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DOES WILDLIFE MANAGEMENT PAY ?

PROFITS FOR THE FARMER

By Charles A. Dambach¹ and Ernest E. Good²

THAT the farm wildlife crop is widely utilized by sportsmen and multitudes of other recreation seekers from urban centers has been realized for some time, but it is only recently that the management and utilization of this crop has been given due consideration from the farmer's viewpoint. The interest of the sportsman and nature enthusiast is assured, since these persons benefit from the farmer's efforts at little or no expense to themselves. The farmer's interest in maintaining this resource, which only he is in a position to control, depends, however, upon his conviction that wildlife management is a profitable practice on his land.

The returns to the farmer from wildlife management are by no means all economic, and the objectives may vary widely from one place to another. Management may be designed to maintain a population of desirable wildlife, to keep crop pests in check, or to provide permanent erosion-control cover for critical areas on the farm. The farmers may wish to produce fur or game animals to be marketed, either directly or through the sale of hunting, fishing, or trapping rights. To others the assurance of outdoor recreation for the immediate family and friends may be the chief consideration.

Under average farm conditions, wildlife management cannot be expected to return large dividends on a per-farm basis, yet the income per unit of area may be surprisingly large when land not suitable for other crops is wisely managed for wildlife production. Moreover, wildlife is a crop to which all the land of the farm can be made to contribute, over and above its primary function.

On the average farm, intensive management is neither necessary nor desirable. Permanent wildlife improvements are brought about by adjusting land to proper agricultural use, avoiding acts detrimental to wildlife, encouraging the development of vegetation favorable to wildlife whenever consistent with good land use, and using good judgment in harvesting the wildlife crop.

Managed production of fur bearers may yield a worthwhile though small income on the average farm, and more substantial returns on land more favorable for fur management. With proper care surprisingly small

areas may be made highly productive. Almost any patch of cattails will produce muskrats if there is permanent water and if the homes of the animals are not disturbed. According to Enders, an acre of such ground, if properly managed, may be made to produce from 10 to 25 muskrats a year. In Ohio muskrat skins bring from 75¢ to \$1.40 each.

At Howell, Mich., where there is much "idle" marshland, one farmer's son has earned about \$200 a year trapping muskrats from a hundred acres of marsh with no management. A farmer in the Salt Creek watershed in Ohio has taken nearly a hundred dollars' worth of furs per year from a marsh of less than 20 acres which was created in an abandoned coal-strip area.

A survey in Muskingum County, Ohio, during the 1934-35 trapping season, revealed a total fur crop sold to local buyers of 29,379 pelts with a cash value to the trapper of \$26,300.70. The value of furs shipped to mail-order houses was estimated at 15 percent of the total sold to local buyers. This brought the total estimated income from raw furs in the county for this period up to \$30,245. On an acreage basis this represents approximately a dollar's worth of fur for each 12 acres of farm land in the county, or an average of about \$8 per farm. With proper management, at little expense this income could be increased several fold.

The harvesting of wildlife for food has been profitable mainly to a few individuals who have taken advantage of their neighbors' generosity or indifference. For example, one farmer and his two sons in western Tennessee trapped or shot 400 rabbits, during the open season in 1937, on their own and neighboring farms. The rabbits were sold for 15¢ each, a total of \$60.

Hunters harvest by far the biggest share of the annual game crop. This presents a perplexing problem to the farmer who is interested in improving conditions for wildlife but is hesitant to do so because of frequent abuses by the hunters.

Damage to fences and livestock is a constant threat, and attempts personally to control trespass often result in unpleasantness that is most distasteful to the average farmer; he feels that a point-blank refusal to permit hunting on his place would be inhospitable. As a result, all too generally a multitude of friends, relatives, acquaintances, and others, impose upon his good nature until, in desperation, he posts his farm against

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DOES WILDLIFE MANAGEMENT PAY ?

hunting. Most farmers find it easier to tack up "no hunting" signs and hope they will be heeded, than to make a face-to-face refusal to each person requesting permission to hunt. This is well indicated by Lithgow Osborne's report at the Twenty-first American Game Conference, in 1935, in which he stated that two members of the New York Conservation Department, traveling as ordinary sportsmen, were refused permission to hunt at only 1 out of over 40 posted farms at which they stopped.

In many instances farmers who are otherwise interested in wildlife have hesitated to improve or maintain conditions favorable for game because of the certainty of the resultant increase in hunting pressure and its abuses. Some few, however, have worked out various plans by which the number and desirability of hunters can be controlled. Some of these plans have resulted in substantial remuneration from the sale of hunting rights.

Practically all of the systems in use in the Ohio Valley region are based upon the procurement, by persons desiring to hunt, of a written or printed permit from the farmer. Of these, the Williamston plan and the Wood County system have received most notice.

Under the Williamston plan, which originated in Williamston Township, Ingham County, Mich., anyone wishing to hunt must first obtain a ticket from a farmer belonging to the group. On the tickets are the name of the organization and the instructions to the hunter to park his car in the farmer's yard, to be careful with guns and fire, to close gates, and to climb fences at posts. He is reminded to obey the game laws, to be courteous, and is requested to come again. The ticket is issued without charge, and is returned by the hunter when he leaves the farm. The number of tickets per farm is decided each year on the basis of a majority opinion concerning the abundance of game. Usually not more than four tickets are issued to any one farm; this prevents too many hunters being on the land at one time. One of the tickets is often reserved for the landowner or his family.

The organization is generally built around some community enterprise such as a church or school. A president, secretary, and a board of five directors from representative parts of the area are elected each year. The area is posted with signs provided by the State department of conservation.

The Wood County system originated in Plain Township, Wood County, Ohio, in 1930. Different associations sell season permits to sportsmen at prices ranging from \$2 to \$3.50, making the purchaser a member of the association and entitling him to hunt on any of the lands within its boundaries during the hunting season. The landowner or his children may hunt over the whole territory for 25¢. Other residents of the area who do not own land are charged 50¢ each. The money is used to pay for printing signs and posting the land, employing special deputies to patrol the territory, winter feeding, and various other game-management measures. A part of the annual income may be given to the community church or school, and the remainder is prorated to the farmers on an acreage basis.

Variations of this system are being tried in many parts of Ohio. In the Indian Creek Game Protective Association, organized by Butler County farmers in 1936, each farmer receives a permit for each 15 acres on his farm. He pays the association 25¢ for each permit, and sells it to the hunter for 50¢. The permit is good for 1 day's hunting on the farm of the man who sells it. If he sells no permits he pays 1⅓¢ per acre for protection against trespass. Most of the funds of the organization are used to employ deputies to patrol the territory during the hunting season.

It should be borne in mind that the organization of a managed hunting area is purely a local problem and any such plan must be made to meet local conditions. The Wood County system, wherein the association member may hunt over all of the farms in the area, is satisfactory in northwestern Ohio where similar hunting conditions exist on practically every farm. It is not satisfactory, however, in southwestern Ohio or in other territories where the topography tends to vary the agricultural practices so that some farms provide much better hunting than others. But these problems are readily solved if given concerted thought and effort under capable leadership by farmers and sportsmen with a real interest in perpetuating game.

Control of hunting, however, is only part of wildlife management, though it is becoming increasingly necessary, especially near large urban population centers. A direct cash return from the sale of furs and of hunting or fishing rights is important as an incentive to the farmer to make positive provision for the welfare of his wildlife. The greatest value of sound wildlife management on the farm, however, is biologic, for the natural flora and fauna profoundly affect every farmer in his economic and social relationships with the land.



WILDLIFE IN THE LAND UTILIZATION PROGRAM

By Walter A. Peterson¹

THE LAND utilization program² of the Department of Agriculture has been concerned primarily with effecting needed adjustments in the pattern of land ownership and land use in distressed submarginal agricultural areas. Four major types of development have been planned and initiated on land utilization project areas: (1) grazing, (2) forestry, (3) wildlife conservation, and (4) recreational facilities.

To the end that best results might be obtained in planning wildlife adjustment on land utilization areas, the advice and help of other governmental and State agencies primarily engaged in wildlife conservation were sought. In this connection, 32 projects with a total area in excess of 722,000 acres, located along the principal flyways in 16 States, were purchased for the Bureau of Biological Survey to be developed and administered by that agency as migratory wildlife refuges. Large areas of marshland reclaimed in cooperation with State agencies from unprofitable agricultural use already have demonstrated their usefulness for migratory wildfowl, and for fur bearers, such as otter, mink, beaver, and muskrat. Under the favorable conditions which have been created, and with proper management, the administering agencies should be able each year to obtain substantial fur revenues from these areas. Wildlife censuses, taken before and after work done over a 3-year period, indicate increases far in excess of expectations.

On projects in the Southeast, extensive operations have been carried on to reestablish cover, food, and favorable environment for upland game species, especially bobwhite. Several hatcheries have been constructed for rearing bobwhite and turkey for release on project areas. This stocking, coupled with correction of deficiencies in food and cover, and the closing of the areas to hunting, has resulted in gratifying increases.

Two large hatcheries for the production of warm-water fishes, such as bass and bream, were constructed, one on the Sandhills project near Hoffman, N. C., and the other on the Welaka project near Welaka, Fla. Another hatchery is under construction on the

Arcadia project in Rhode Island. The first two are now administered by the Bureau of Fisheries, and upon completion the other will be transferred to the same agency.

On many of the projects, particularly those in the East and South, considerable attention has been given to the creation of ponds and lakes to provide local fishing and to serve as resting and feeding places for migratory waterfowl. Stream improvement also has been undertaken on projects where natural environment gave promise of success for this type of work, and many rearing pools have been constructed to add to the efficiency of the fish restocking activities.

Sanctuaries have been established in cooperation with State agencies for the protection of all types of native wildlife found on the areas. In some instances tracts containing primeval growth and environment were purchased for the perpetuation of species in danger of extinction. For example, primitive areas harboring several colonies of ivory-billed woodpeckers were purchased in Florida and are to be preserved in their native State. On one Minnesota project a small herd of woodland caribou probably was saved from extinction by protective measures and by the introduction of 10 animals from Canada to augment the pitifully small remnant of this species in the continental United States.

The summary shown below indicates the character and extent of wildlife development accomplished during the 3-year period ending with 1938.

Summary of Wildlife Developments on Land Utilization Projects to Dec. 31, 1938

Area covered by biological reconnaissance	acres	192, 250
Refuge boundaries cleared and posted	miles	161
Wildlife refuge fencing	do	111. 6
Area established as game food nursery	acres	25
Area planted for food and cover	do	32, 741
Forest slashings to improve wildlife environment . do		33, 141
Game farms and fish hatcheries constructed and operated		8
Game and fish protection and restocking	All areas	
Fish and game shelters established		1, 989
Fish-rearing ponds established		78
Area covered by lake and pond development	acres	20, 949
Stream improvement	miles	573. 4
Stream and lake bank protection	acres	88
Dike and jetty construction	feet	142, 200
Impounding dams built		326
Diversion ditch construction	rods	583

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² The Land Utilization Program referred to in this article was initiated under the Agricultural Adjustment Administration, cooperating with the Federal Emergency Relief Administration in the summer of 1934. Its functions were transferred to the Resettlement Administration when that administration was established April 30, 1935. On September 1, 1937, the name of the Resettlement Administration was changed to the Farm Security Administration. On June 9, 1938, land-use projects were transferred to the Bureau of Agricultural Economics, then on November 1, 1938, to the Soil Conservation Service.

UTILIZING FARM PONDS FOR WILDLIFE

By Cecil N. Davis¹

IN MUCH of the Midwest and West, shortage of water is a serious problem both in wildlife management and in farm and range management. Experience during the droughts of 1934 and 1936 revealed that surface water supplies are inadequate to last through extended periods without rain.

In erosion-control work it has been found that, frequently, the least expensive method of controlling gullies is by means of water-impounding dikes. Likewise, a properly located pond often makes it possible to utilize an eroded cultivated field by converting it to pasture, or to maintain better distribution of the grazing load on present pasture or range and thereby reduce soil loss.

By proper management of surface water the soil is protected from trampling and the water from pollution by livestock, silting may be reduced to a minimum, and the cutting action of waves on reservoir banks may be eliminated. Furthermore, in few other sites is there such close connection between soil conservation and wildlife conservation—with carefully chosen plants, proper planting methods and occasional special treatment, water supply sites may be made into wildlife habitat that cannot be excelled.

The recommendations here presented are the results of observation and experience in Missouri and southern Iowa. They should be useful, however, over a much wider area in the same general region.

Because of their rarity, springs and swamps in this region should have special care. Oftentimes inexpensive structures can be built to concentrate water into ponds where it may support luxuriant marsh vegetation valuable for wildlife food and cover. Fences should be built around such areas.

The needs of a variety of wildlife should be kept in mind when the development of a water area is being planned. If the site is a prairie the habitat should be made suitable for waterfowl and for prairie dwellers native to the area; but a greater variety of species may be served where there are more diversified cover and food conditions. If possible, additional food and cover areas adjacent to the water area should be developed and protected to increase the value of the water facility for wildlife.

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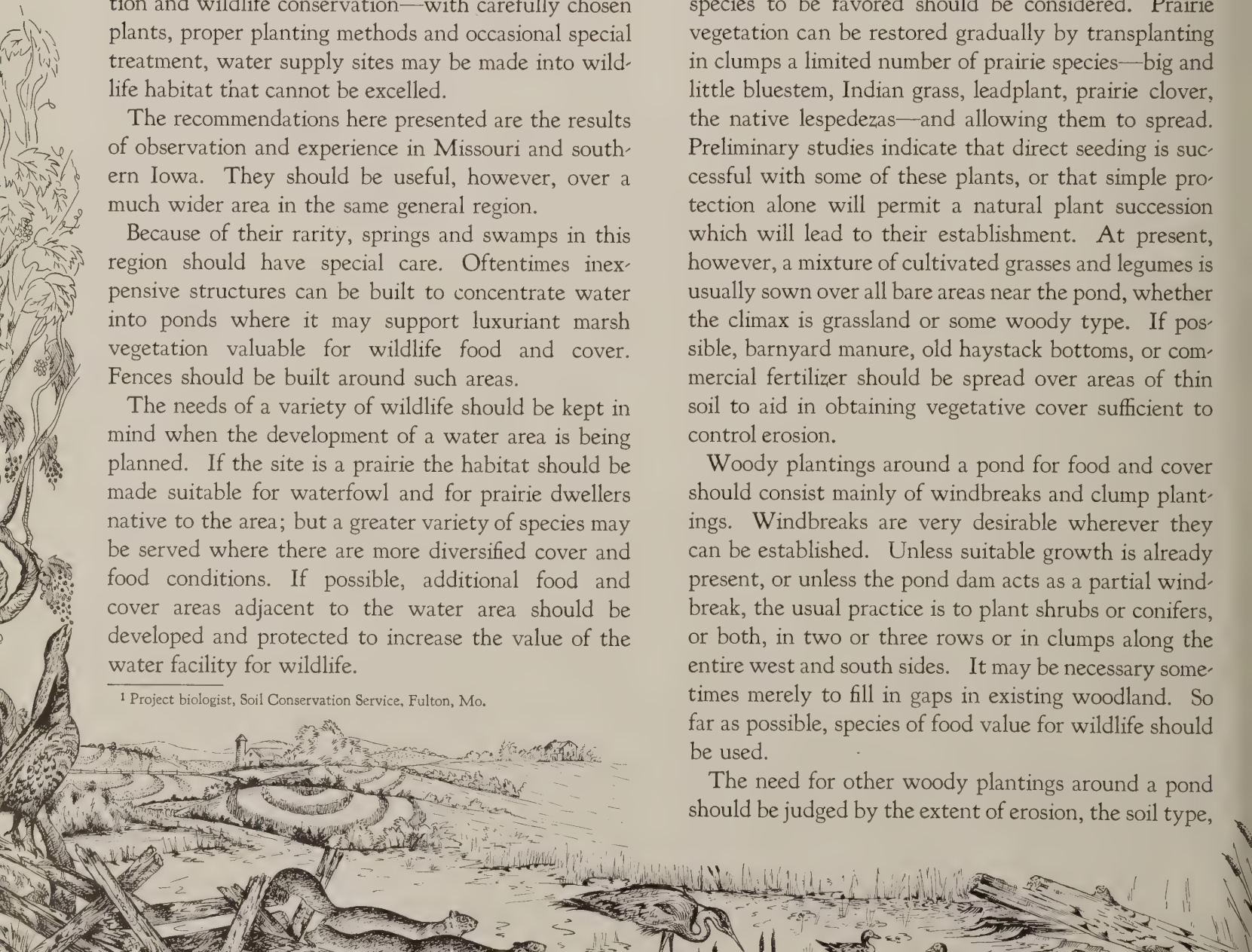
The possibilities of fish production should be considered. On many farms there are brush, logs, sand, and rocks that can be used to make fish shelters and spawning beds; often this suitable material is moved from the site before the reservoir is constructed. Fish screens are often necessary, but care must be taken to prevent clogging.

Of first importance are fences to exclude livestock, and they should be well above the water line to allow a dense cover growth around the pond margins. Livestock is watered outside the fenced area in tanks fed by gravity from the main water supply; or the fence may be inset so that stock can reach one edge of the impounded water. Small watersheds are often fenced with the ponds. In any event, it is essential that erosion be controlled on the entire watershed.

Proper cover both on the entire watershed and on the immediate banks is essential for the protection of a pond or reservoir. In planning these developments the character of the original vegetation and the wildlife species to be favored should be considered. Prairie vegetation can be restored gradually by transplanting in clumps a limited number of prairie species—big and little bluestem, Indian grass, leadplant, prairie clover, the native lespedezas—and allowing them to spread. Preliminary studies indicate that direct seeding is successful with some of these plants, or that simple protection alone will permit a natural plant succession which will lead to their establishment. At present, however, a mixture of cultivated grasses and legumes is usually sown over all bare areas near the pond, whether the climax is grassland or some woody type. If possible, barnyard manure, old haystack bottoms, or commercial fertilizer should be spread over areas of thin soil to aid in obtaining vegetative cover sufficient to control erosion.

Woody plantings around a pond for food and cover should consist mainly of windbreaks and clump plantings. Windbreaks are very desirable wherever they can be established. Unless suitable growth is already present, or unless the pond dam acts as a partial windbreak, the usual practice is to plant shrubs or conifers, or both, in two or three rows or in clumps along the entire west and south sides. It may be necessary sometimes merely to fill in gaps in existing woodland. So far as possible, species of food value for wildlife should be used.

The need for other woody plantings around a pond should be judged by the extent of erosion, the soil type,



the cover already present, and the wildlife species expected to use the area. The requirements of prairie ponds in this connection have been discussed. It should be recognized, however, that some areas not located on prairies may be so isolated from good brushy cover as to approximate prairie conditions. For such locations, unless the enclosed area is large enough to make good escape cover plantings possible, the habitat should be developed mainly for song and insectivorous birds and for waterfowl. This would require few if any plantings in addition to the windbreak.

For typical nonprairie locations, the shrubs and tree plantings for erosion control should include sufficient clump plantings of mixed shrubs and vines to provide good escape cover for quail and rabbits and a travel lane toward other cover outside the protected area. It is advisable, however, to leave a considerable part of the area in grass or other low-growing cover for ground-nesting species of wildlife. As great a variety of adapted plants as feasible should be the goal.

If the reservoir is to be used for fish or wildfowl, deciduous trees should be planted sparingly near the water. Such low species as mulberry, which does not reseed readily but which has great value as wildlife food, are favored for this purpose. A few planted along the south bank of a pond will help to cool the water without making heavy leaf deposits dangerous to fish, or growing high enough to impede the flight of ducks. River birch, red cedar, and black cherry also may be used.

Marsh or aquatic vegetation may be planted in new water areas to serve as a buffer against wave action, to strain silt from inflowing water, or to bind banks against erosion. At the same time, the plants may be chosen for their ability to provide food and cover for upland wildlife, nesting cover and food for wildfowl, and suitable fish habitats.

In a previous article in *SOIL CONSERVATION* (January 1937, p. 153) the importance of marsh and aquatic plants for use on reservoir banks and in shallow water was discussed. Since that time other plants have been introduced successfully into ponds over a wide area. The longer period of observation enables us to include additional species in the list of plants for the southern Corn Belt, and to recommend the use in each pond of at least two species in each class of plants; i. e., the silt-strainers, the bank-binders, and the wave-breakers. In addition we find that it is advisable to include a few adapted shrubs for nesting cover and food, and a few annuals to make quick growth on mud banks in drought years.

All the perennial aquatics are easily transplanted.

This is best done in June so that sufficient root growth can be made before winter. Several species may be propagated by seeding.

The silt-strainer group is so designated because these plants form thick growths in silt beds. They are usually planted in broad bands across reservoir inlets from a point several feet above the water line to a depth of 12 inches in the water. Most of the species producing cover for waterfowl are included in this group.

The bank-binders are tenacious species best adapted to grow on the least fertile parts of the pond banks. Plants in this group must be able to withstand both flooding and drought conditions, often within a period of a few weeks, since wide fluctuations in water levels are common in this region.

The wave-breaker group is composed of plants often rooted on the bottom in 2 or 3 feet of water, but with leaves or stems floating on or near the surface. These plants, if aided by windbreaks, are usually able to control waves on small ponds. In larger reservoirs it has been observed that the best supplemental protection is afforded when the banks shelve very gradually into deep water, as where a long delta has been laid down. Quantities of aquatic insects and smaller plants eaten by small fish are supported and fed by the submerged portions of these plants, and much fish shelter is also afforded.

Aquatic shrubs are of value in supplementing the work of both the silt-strainer and bank-binder groups. Other aquatics that occur naturally in springs and spring sloughs also can be planted in spring pools developed for wildlife.

Lists of plants recommended for use in and around water areas in Missouri are presented here in the hope that they may be of use to persons interested in correct plantings.

Species for Planting Above Shore Line

Woody Plants.—*Amelanchier* spp., serviceberries; *Cissus ampelopsis*, heartleaf ampelopsis; *Cornus* spp., dogwoods; *Crataegus* spp., hawthorns; *Diospyros virginiana*, persimmon; *Juniperus virginiana*, red cedar; *Machura pomifera*, Osage orange; *Malus* spp., crab apples; *Morus* spp., mulberries; *Parthenocissus quinquefolia*, Virginia creeper; *Pinus echinata*, short-leaf pine; *Pinus ponderosa*, western yellow pine; *Pinus sylvestris*, Scotch pine; *Prunus americana*, wild plum; *Prunus virginiana*, chokecherry; *Rhus* spp., sumac; *Rosa* spp., wild roses; *Sambucus canadensis*, elderberry; *Smilax* spp., greenbriers; *Symphoricarpos orbic-*



culatus, coralberry; *Viburnum* spp., Viburnums; *Vitis* spp., wild grapes.

Herbaceous Plants.—*Andropogon furcatus*, big bluestem; *Andropogon scoparius*, little bluestem; *Andropogon virginicus*, broomsedge; *Chamaecrista* spp., partridge peas; *Helianthus* spp., wild sunflowers; *Lespedeza*, lespedeza; *Sorghastrum nutans*, Indian grass.

Uses of Marsh and Aquatic Species

	Silt-strainers	Bank-binders	Wave-breakers	Spring and spring slough species	Wildlife food
<i>Acorus calamus</i> (sweetflag)		x			x
<i>Bacopa rotundifolia</i> ¹ (waterhyssop)			x		
<i>Carex</i> spp. (sedges)	x	x			
<i>Cephalanthus occidentalis</i> ² (buttonbush)	x			x	x
<i>Ceratophyllum demersum</i> ³ (coontail)			x		
<i>Chara</i> spp. (muskgrasses)				x	
<i>Cyperus</i> spp. (Cyperus)					x
<i>Cornus</i> spp. ² (dogwoods)	x				x
<i>Dianthera americana</i> (waterwillow)				x	
<i>Echinochloa crus-galli</i> ¹ (duck millet)	x	x			x
<i>Eleocharis</i> spp. (spikerush)	x	x		x	
<i>Hibiscus</i> spp. ² (swamp mallows)	x				x
<i>Jussiaea diffusa</i> (water primrose)			x		
<i>Leersia oryzoides</i> ¹ (rice cutgrass)	x	x			x
<i>Myriophyllum</i> spp. ³ (watermilfoil)			x		
<i>Potamogeton</i> spp. ³ (pondweeds)			x	x	
<i>Polygonum</i> spp. ¹ (smartweeds)	x				x
<i>Radicula nasturtium-aquaticum</i> (watercress)				x	
<i>Sagittaria</i> spp. ¹ (arrowheads)		x		x	x
<i>Sambucus canadensis</i> ² (elderberry)	x				x
<i>Saururus cernuus</i> (lizard's-tail)				x	
<i>Scirpus americanus</i> (three-square)		x			
<i>Scirpus fluviatilis</i> (river bulrush)	x				
<i>Scirpus occidentalis</i> (soft-stemmed bulrush)	x				x
<i>Sparganium</i> spp. (burreeds)	x	x			
<i>Zizaniopsis miliacea</i> (southern wild rice)	x	x			x

¹ Annuals.
² Shrubs.
³ Valuable for waterfowl; not to be planted in fish ponds.

CASH IN THE RANCHER'S POCKET

(Continued from page 226)

A fifth point is that these ranches, where protection is given the range and where rigid control of hunting is practiced, are said to be the only lands within the State in which deer and turkey populations are not declining, although they are by no means the only territories adapted to these species. Several of the preserves where little or no management is practiced still have a good many deer, but the population is gradually being reduced. On many areas which could be made into good deer country, but are now open to free hunting, the deer and turkey populations have, for all practical purposes, disappeared.

There remain, however, some good deer and turkey-shooting areas on farms in Texas. A few ranchers, under the direction of the game commission, have set up preserves and charged enough for the privilege of hunting on them to make it profitable to maintain game populations. It is claimed that such commercialization of hunting deprives certain classes of people of the hunting privilege. But considering the steadily diminishing supply of game under the free hunting system, and the mounting costs involved in finding and bagging it, the validity of such a claim may be seriously questioned. The sportsman who cannot pay the price does not get even the "free" game; and each season the price reaches a new high because the game population drops to a new low.

Actually, free hunting passed with free land. It is now a delusion for which we pay a terrific toll in wildlife of all sorts. The State may own the game, but he who owns the land determines whether or not it shall live or die. The landowner may not kill out of season or exceed the bag limit, under penalty of the law. But he may, by destruction of habitat, wipe out at one stroke the entire wildlife population of his lands, and the State cannot lift a finger. Of course, no landowner would deliberately do such a thing, but thousands are doing it, little by little, either because they do not understand the needs of wildlife or because economic pressure drives them to wring some return from every acre.

Wildlife management is a practical art. General application of its principles would ensure the maintenance of reasonable wildlife population in perpetuity. But the most important management measure—the provision of adequate habitat—must be carried out on the land, and this involves trouble and oftentimes expense. If we can set in operation a system that will make it worth while for the landowner to practice wildlife management we can without question reverse the present downward trend in farm and ranch game. Is Texas pointing the way?



Wildlife Management Publications Feature This Month's Compilation

For **REFERENCE**
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Handbook of Wildlife Management, Regional Office, Spartanburg, S. C. SCS-RB-3. mm. March 1937.¹

Handbook of Wildlife Management, Regional Office, Rapid City, S. Dak. SCS-RB-7. mm. November 1937.¹

Wildlife Conservation by the Soil Conservation Service. Presented at the Hearing before the Select Committee on Conservation of Wildlife Resources, House of Representatives, 75th Congress, Washington, D. C., on May 10, 1938. mm.

Wildlife Conservation Program of the Soil Conservation Service. SCS-AR-3. mm. June 1938.

Wildlife Management—Erosion Control in the Central Great Plains Region. Regional Office, Salina, Kans. SCS-RB-6. mm. August 1937.

Wildlife Management Principles: Prepared for SCS Technicians in Region 6. Regional Office, Amarillo, Tex. mm. July 29, 1938.

Office of Information U. S. Department of Agriculture

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The Nation and the Soil—The Problem: Drained Areas and Wildlife Habitats. Yearbook Separate 1611, pp. 77-83, 1938 Yearbook of Agriculture.

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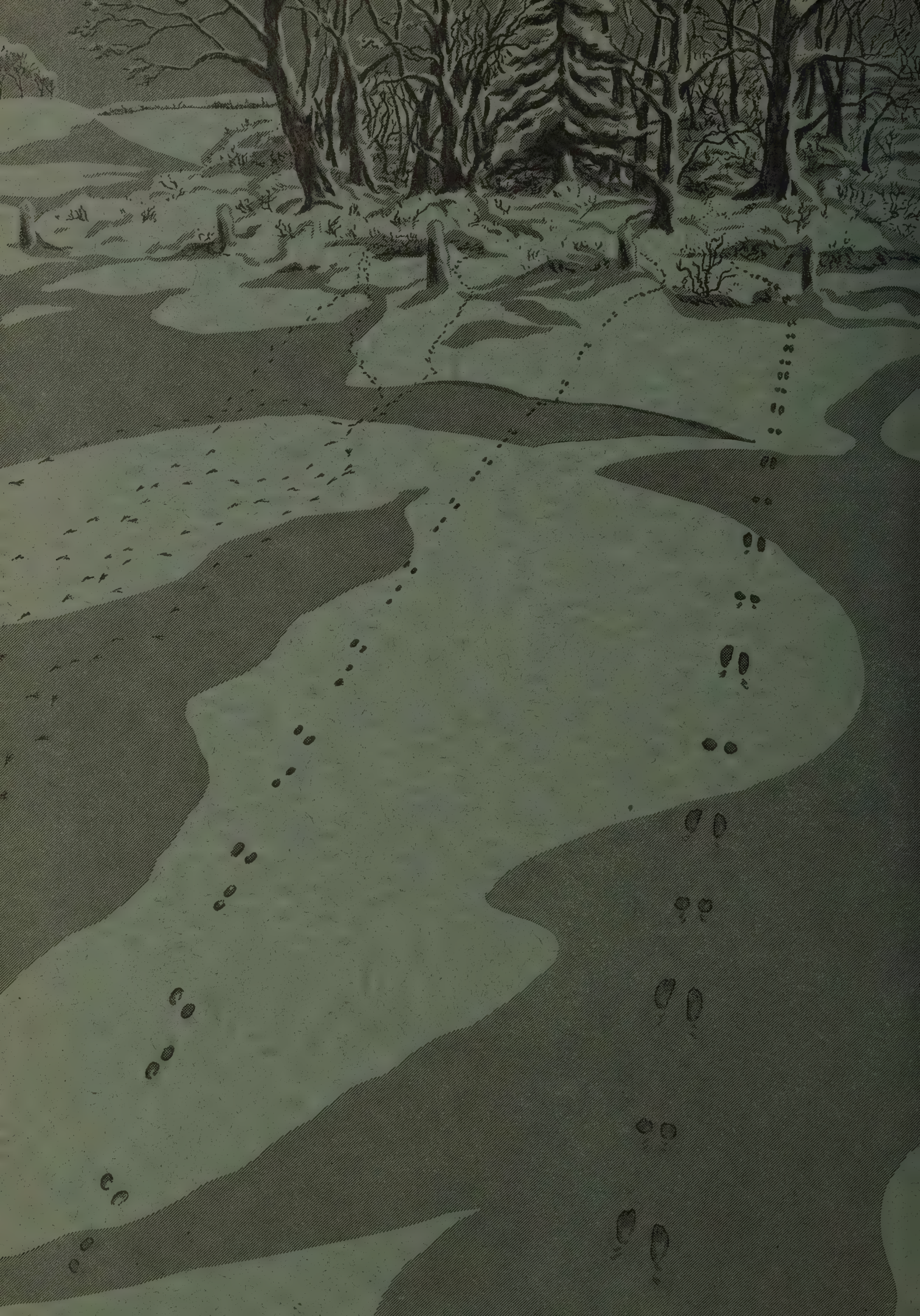
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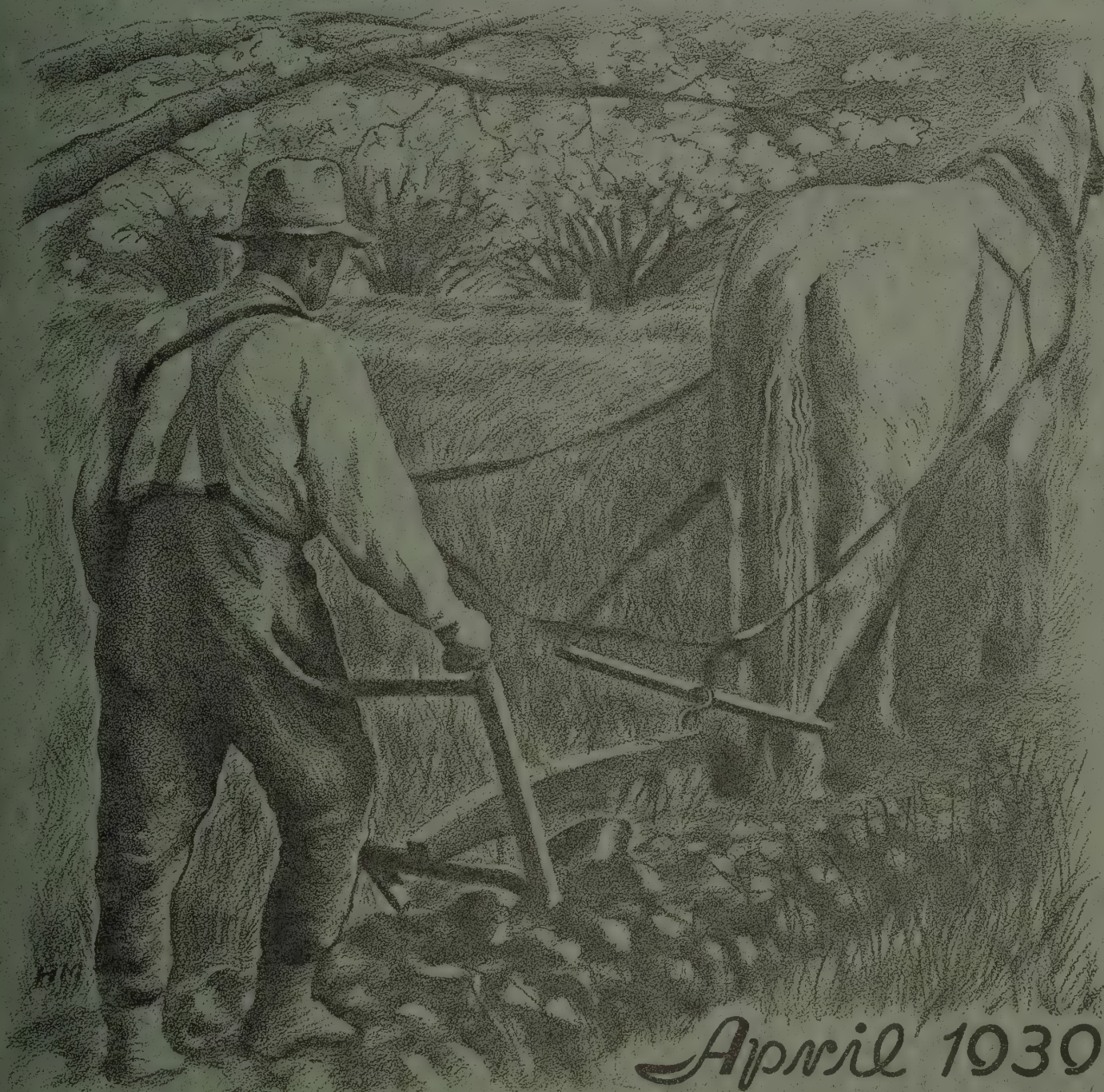
² From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

(For additional references on wildlife conservation, see previous lists.)



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There's a close relationship between farming and forestry in western Washington. The fertile bottomland soils are the basis of a thriving dairy industry. The hillside lands are best adapted to woodland use.

Profit for Farmers in Washington's Second-Growth Forests

By FLOYD L. OTTER ¹

TO CLEAR or not to clear—this has long been a question for debate in the far Northwest, in the timbered domains of Washington, Oregon, and northern Idaho. And, more often than not the debate turned out in the end to be merely a concerted lamentation, with no one suggesting a practical alternative to clearing. Nor did this in the least dampen the enthusiasm of the hardy settlers in burning and blasting the forest out of their way to the soil, poor soil or good soil, so that the cut-over land could be opened for sale and settlement. Many men, in the earlier times, gained rich reward from converting original bottomland forest into valuable cropland. And once these

fine timber stands had succumbed to the logger's ax and the soil to the domesticating plow and drill, with each passing year the new carvings pushed the forest boundaries farther and farther inward and upward. As cutting penetrated into the uplands poorer soils were encountered, and today the foothills are rife with failure and disillusionment. Efforts to farm the poorer soils have proved illusory—a "starve out" financial venture woefully contributory to stream flooding and soil erosion losses.

And yet these thousands of acres of cut-over uplands, if properly handled, will produce trees over and over again, as is attested by great expanses of second- and third-growth timber that has grown up on un-

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This woodland on a farm in northwestern Oregon provides a protective cover for steep hillsides while growing a wood crop. The older trees have served their purpose as parent trees and, together with thinnings in the young growth, may now be cut to pay the carrying charges on the land until the young stand matures.

molested land. What, then, is the lesson to be drawn? The answer may come from this second-growth timber itself. Why may it not become a remunerative crop, sandwiched in with such other crops as are adaptable on the better soils of contiguous cleared lands—a wood-farming combination, for the sake of agricultural stability and for the sake of the soils?

Certain it is that the fate of the soils and the economic destiny of the Northwest are closely bound up with wise utilization and replenishment of timber. Both at present and for all time to come, as far as can now be told, much of the Northwest's income must be derived from the ring of the logger's ax, the vibrant crash of falling trees and the roar of the sawmill. Screaming saws and insatiable printing presses must be fed; the driving harvest of forest crops must go on. And, from an industrial point of view the Northwest is still well equipped to turn out a continuing stream of lumber and timber byproducts. Sawmill and wood-pulp plants are geared for huge outputs. A pattern of life has been built around the forests. But what of the future source of supply to keep the mills running?

No one will deny that forest management on a large commercial scale is the foremost consideration; but supplemental farm forestry offers much greater possi-

bilities, from the point of view of both the farmer and the industrialist, than is commonly realized.

From an economic point of view, the potentialities of farm forestry are twofold and interlocking: First, by developing his cut-over land a farmer may augment his income; and, second, auxiliary timber supplies from farm woodlands will help to keep the mills operating. Thus by a circle of self-help and mutual assistance, agriculture may become more profitable and dependable, market outlets for timber crops may be assured, and an important industry may be perpetuated—with attendant fortification of pay rolls, buying power, and tax resources.

Certainly, the field for more wood farming to fit into the scheme of things is wide open—in Washington, especially. Even now, woodlands on Washington farms occupy a larger area than does wheat, and considerably more woodland exists which could be added to farm units. Approximately one-fourth of the privately owned forest land and one-tenth of the total forest area is classified by the Census Bureau as farm woodland, including woodland pastures. Two-thirds of the State's 39 counties are important woodland counties, and in them farm woodlands occupy 38 percent of the total acreage in farms.

According to the 1935 census, 30 percent of the State's farm families benefit from the sale of such forest products as fuel wood, sawlogs, pulpwood, rough lumber, telephone and power poles, fence posts, Douglas fir piling, veneer logs, cross ties, shingle, and stave bolts and hardwood furniture logs and handle stock. Other products, such as Christmas trees, wild berries, and cascara bark, are locally important. The 1935 census shows that the 7,721 farms reporting in 1934 (9.2 percent of all Washington farms) sold forest products valued at \$660,859, the average per farm being \$86. This income is only an indication of the possibilities, since the farm woodland in Washington is a neglected crop. Too often the possibilities in sustained-yield woodland management have been minimized, and this has brought about the clearing of land unsuited to cultivation. The results have been serious soil and water losses and, not infrequently, land abandonment.

How can woodland be made to contribute its full share to a permanent and dependable farm income? For 11 years, Carl Chilman, a farmer living near Rockford in Spokane County, Wash., has operated his woodland as a profitable side line. In cooperation

with the Soil Conservation Service, he is now using a plan designed to make this income permanent. His farm is typical, in physical characteristics, of thousands of others in the older cut-over area of the Pacific Northwest. He went into wood farming without forestry or logging experience.

Before he signed his agreement with the Soil Conservation Service, Mr. Chilman had been cultivating 107 acres of moderate-to-steep land with forest-type soil, using methods that had resulted in the loss of 25 percent to over 75 percent of the topsoil in the 15 years since the land was cleared for farming. He has supplemented his income from grain and dairy products, each year, by selling fuel wood, rough lumber, pulpwood and sawlogs, to the value of about \$420. These woodland products he took from 275 acres of second-growth forest. He cut his timber without regard to growth or reproduction and expected it to last 20 years. Toward the last of this era of harmful methods on the Chilman farm the land seemed destined for abandonment in the not distant future.

And then with enthusiasm Mr. Chilman adopted conservation farming. The initial objective behind his new farm plan was to arrest and reverse the

West coast forests when cut over and the forest floor exposed to dry summer weather burn with fierce intensity. Since the duff and humus on and near the surface of forest soils is comparable to the topsoil of prairies, a single fire may be as destructive as complete removal of the topsoil by erosion. This land has produced at least one crop of second-growth timber since the old growth was removed, but repeated fires which followed cutting have reduced it to this condition. A heavy growth of bracken fern, which in itself is a serious fire hazard, is the principal vegetation which follows such fires. Planting to native tree species, with suitable fire breaks, is the practical method of putting the land to work and at the same time reducing the fire hazard. This land belongs to Snohomish County and is being reforested with the cooperation of the Soil Conservation Service.



trends leading toward failure, through methods within the means of the farmer. On the fields where erosion was already serious, he reduced his grain acreage and materially increased that of the forage crops. In his woodland, instead of cutting the timber and plowing for crop production, he adopted an active erosion preventive measure—a cutting system by which he can cut his timber and still keep it, and, by wise selection of trees, increase its value.

During the first winter, by cutting trees marked by Soil Conservation Service foresters on the basis of stand improvement, Mr. Chilman harvested forest products valued at \$900. Thus, with his woodland as a source of labor and cash income, he was able to reduce his cash-crop acreage and to adopt other soil conservation practices. His future farming system will be based on dairying and logging, with timber replacing the soil-depleting wheat as his main cash crop.

The plan for the Chilman woodland was based on an inventory of the timber stand and the estimated rate of growth of the various classes of trees. His 275 acres was found to be growing 49,000 board feet a year; and this, therefore, is the amount he can cut on a sustained-yield basis. An additional 107,000 board feet of over-mature timber is reserved to pay off the mortgage when it becomes due and to provide for a new set of farm buildings. The annual cut may be converted into lumber at the farm or sold in the form of sawlogs, pulpwood, or fuel wood, and represents a return for labor, taxes, interest, and logging equipment of from \$400 to \$700 per year.

This type of woodland is valued at only about \$6 an acre, since more than half the area is newly cut-over land or young pole stands. At 4 percent, the interest on the investment on 275 acres would be \$66. Taxes and fire-protection assessments are about \$25 a year. The difference, then, between the carrying charges of \$91 and the value of his annual salable products is a net return for labor and equipment of \$300 to \$600 a year, not including the fuel wood, posts, etc., used on the farm. After the unproductive openings and the ill-formed and slow-growing trees are eliminated, this annual income should be doubled.

The experience of Mr. Chilman, whose land is in that part of the State characterized by relatively large farms with an average woodland area of 100 acres, typifies the economic possibilities in the wooded area of eastern Washington.

About half the State's present farm woodland is west of the Cascade Mountains where the average size of farms is relatively small. In Snohomish County, for

example, the average is 30.7 acres, with approximately half in woodland; and here, cooperative action in marketing and other timber operations similar to that initiated in Coos County, N. H., and Essex County, Vt., and in West Virginia, is indicated as important in an approach to the farm forestry problem. The possibilities are excellent for farmers to acquire nearby areas of thrifty second-growth timber and convert them into permanent farm or community forests.

The management of woodland as a cash crop is particularly attractive in western Washington. Nearly every farm has timber growing on nonagricultural soils or along river banks where trees are necessary for bank protection. Timber growth is remarkably rapid in the area, some stands producing at the rate of 6 to 8 percent compound interest. Some species, such as cottonwood, produce a merchantable crop in 15 to 20 years, and forest products of high value, such as cedar poles and furniture logs, can be raised in a short time. The wood-using industries are so large and numerous that all farm woodland products can be absorbed without hardship to the logging operations in virgin timber areas. Large quantities of logs and pulpwood are now imported from British Columbia.

In forest areas with little good agricultural soil, the traditional cycle of land exploitation usually ends in discouragement. First, there is the period of booming prosperity while the virgin timber is harvested; second, a gradual or sudden decline in lumber output brings on a decline in employment, in tax returns, in land values, in population, and in the local market for agricultural products; and third, the remaining population is forced to accept a low standard of living based on subsistence farming supplemented by picking the skeleton of timber land ravished by logging and scourged by fires. Finally, such areas are often a burden to the State because of road and school funds which are out of proportion to taxes collected, high costs of law enforcement, heavy relief loads, and excessive tax delinquency.

Washington State has some areas in the third stage of the cycle, and many in the second. A planned, common-sense policy of integrating farming and forestry offers hope for recovery in the third-stage areas, and is indubitably the plain road for stemming the downward trend of property in those areas which are now in the second stage of the cycle. With our present economic system and standards of living, we must give up the false hope of converting the thin gravelly forest-type soils of our foothill areas into 40-, 80-, or 160-acre farms or orchards. We must realize that these lands are by nature low-producing lands

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An exceptional piece of woodland on a farm in northwestern Oregon, classed by the Forest Service as large second-growth. This Douglas fir stand is 75 years old and contains trees suitable for products of high value such as poles and piling. The largest and best trees should be left to grow into high-quality sawlogs and veneer logs. Thinnings may be made in stands much younger than this for low-value products, such as pulpwood and fuel. (Photograph by Forest Service.)



The most spectacular type of erosion on the Snohomish C. C. C. camp area in Snohomish County, Wash., is this type of streambank erosion. Characteristic are narrow strips of tillable land along the stream courses. Continued agriculture is dependent upon protection of the bottomlands as the basis of the agricultural industry, and the protection and management of timber on the hilly lands to provide supplemental employment and income for farmers and raw materials for basic industries of western Washington.

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on a per-acre basis, although they are capable of yielding high returns per dollar or per day of labor invested.

The economic unit for a family in this second-growth timber country is probably at least 400 acres. The ruling principle should be to adapt the type of farming to the land. On the west coast, for example, where there are scores of townships with only 20 percent of the soil suitable for cultivation or improved pasture, the farming system should be of a type to permit profitable use of the remaining 80 percent for timber crops under either farmer or community ownership. Obstacles to the adoption of such a system are more imaginary than real. The inequalities in taxation that burden large timber owners do not as seriously affect farms: fire protection is simplified in settled areas when residents appreciate their timber; the marketing problem can be solved among producers; the principles of timber management and utilization are as teachable as those of pasture management; farmers have no more natural aversion to timber growing as a farm enterprise than they have to milking the cows. To the farmer his timber is a reservoir that can be "tapped"

to supplement farm income in periods of low crop prices or when there are slack seasons in the farm work.

In Washington and the Northwest, the farmers have in their timber a soil-conserving crop which should be cherished as a gilt-edged bond. Through cooperative action and common-sense management, timber may be cut year after year just as bond coupons are cut, yielding profit to farmers and becoming a stabilizing influence upon the wood-using industries and on the whole economic structure of the State. Here, in the proper management of farm timber areas, soil conservationists and foresters have a joint opportunity that merits their attention and that will require their close cooperation.

The adjustment of numbers of livestock to the grazing capacity of any given area is the genesis of proper range management. All plans of management will be futile unless they rest upon this foundation.

—Liter E. Spence.

Effect of Erosion on Long-Time Strip Cropping in Bush Valley, Minnesota

By I. J. Nygard and L. E. Bullard¹

IN southeastern Minnesota, contour strip cropping has been adopted by the Soil Conservation Service as a major weapon in the fight against soil erosion. This is especially true in the two project areas of Gilmore Valley, at Winona, and Beaver Creek at Caledonia. But though strip cropping has been almost universally employed on sloping cultivated land, the practice has not gone unquestioned, even among Service technicians. Although agreeing that strip cropping is effective in reducing erosion, field technicians have argued many hours concerning the extent of its effectiveness and the place that it has in our soil-saving demonstration program.

Such discussions were no doubt inevitable and were certainly valuable. Strip cropping, to those of us who were working with the practice, was a new thing. We had little or no data on which to base definite conclusions concerning the practice's value. Before establishment of the Soil Conservation Service demonstration at Caledonia, strip cropping in that area was practically unknown and no experiment station data on the effectiveness of the device over long periods of time were available.

One of the writers was a member of a soil survey party which in 1937 mapped a large part of a tiny watershed in northern Houston County. The watershed, known as Bush Valley, contains one farm which had been strip cropped for 61 years. We found that cultivated land on slopes which we consider too steep for cultivated crops had eroded much less severely than cultivated land on neighboring farms having equal or even less steep slopes. Naturally, our interest was aroused. We decided to obtain the farm's history and study the land-use set-up in detail. Our findings are presented below.

It was undoubtedly a nostalgia for the mountains of his native country that led H. A. Von Arx, a young Swiss immigrant of 1874, to seek a hill farm. In Bush Valley, Houston County, Minn., he found just what he wanted—land walled in by hills. He was reminded of his home farm in the canton of Solothurn in Switzerland.

Bush Valley lies a short distance above the place where the Root River empties into the Mississippi. Like many tributary creeks at the lower end of the

Root River, Bush Creek has greatly dissected its drainage area in recent geologic times. Its valley now consists of a narrow valley floor and narrow, partly cut-up terraces. The valley gradually ascends a lower or talus slope at the foot of steep, wooded hillsides.

The original Von Arx place, purchased in 1876, consisted of the 40 acres on which the house is located and 40 more acres to the west. Three years later the farm had been increased to 198 acres.

Strip cropping, as used in Switzerland, was employed from the beginning. By 1880, a future son-in-law (W. J. Langen, who now occupies a farm in adjoining Pfeffer Valley) noticed that not only his neighbors but also his father plowed entire fields of sloping land at once, using the square type of farming regardless of slope, whereas the Von Arx fields were operated in horizontal or contour strips—the cultivated strips separated by bands of hay or meadow. As a boy in his teens, Langen often overheard his father talking with the Swiss immigrant about "conturflügen" (contour plowing) and "bergculture" (hill farming). The elder Langen, by the way, was an immigrant from the Black Forest of Germany and a former student at Hohenheim Agricultural School in that country.

The son of the Swiss farmer, who now operates the west 60 acres of the old Von Arx estate, also recalls his father's talk about plowing around the hill, as far back as 1885. Later, the son was taught to plow a strip of sloping land on the level, being careful not to plow up the sodded draws. To serve as a guide in plowing the first furrow of a strip, the son was given the end of a piece of binder twine attached to the bridle of the nearest horse and told to walk on the boundary of the meadow strip either above or below.

Corn strips were not often included on steeper slopes; when they were included they were never wider than 75 feet and were alternated with strips of hay worked into a long rotation. Where corn is planted in strips, the practice has been to keep it on the same strip for 1 year only; never has corn been planted on the same strip 2 years in succession on land above a 3-percent slope. A strip placed in corn 1 year has been returned to small grain seeded to hay the next, and thus returned to meadow for 2 or 3 years.

¹ Soils technicians, Beaver Creek demonstration project, Soil Conservation Service, Caledonia, Minn.



Above.—Joe Von Arx harrowing one of the strips on his farm.



Left.—And here he harvests oats. The strip cropping of a neighbor, Ed Albrecht, is visible in the background.

On some of the steep slopes a strip or two may be plowed in the fall, prepared and seeded to winter wheat, and then returned to meadow.

A common rotation consists of 1 year of small grain followed by clover and timothy meadow which is left on the ground for 2 or 3 years if the stand remains good, followed by winter wheat or corn. When corn is seeded, the practice has been to keep the strip narrower than it otherwise would have been.

In our study of the farm, we found that 15 years ago strips of cultivated crops were generally wider than those found in 1937. Von Arx's daughter and two sons, who now operate the land in two units, found

by observation that less washing occurred on narrower strips during intense rains. The widest strip of clean-tilled or small-grain crops on the slopes of 10 percent or more was 90 feet in 1937. We learned that a 25-foot buffer strip had remained as such for more than 10 years.

The land above this buffer strip was being spring plowed 10 years ago when a torrential rain fell, causing finger gullies in the lower portions of the plowed area and cutting deep gullies in plowed slopes on neighboring farms. It was decided then and there that the slope should be broken up by contour grass strips, and the buffers have remained since that time.

Von Arx pioneered in the use of fertilizers in his community. In the early part of the century, he constructed a manure pit covered by a shed. A manure spreader was purchased in 1905. His practice, continued by his children, was to apply the manure when the fields were in meadow in order to prevent run-off from carrying the fertilizer away.

At the lower end of a field north of the farmstead, a small masonry dam was built previous to 1915. That dam has more than proved its effectiveness in controlling a 6-foot gully and is still intact.

We learned that 15 years ago the steep hillside on the farm was much more heavily timbered than it is today. This is undoubtedly due to the fact that about 35 head of cattle have been permitted to graze in the woods. The pastured timber, as Von Arx's elder son told us, has deteriorated "at an alarming rate" in the last decade and a half.

Interesting incidental information is that Von Arx organized the first cheese factory in the little town of Hokah, Minn.—an enterprise which is still operating.

The elder Von Arx died 21 years ago.

Yields on the farm have been consistently higher than the community average, records show. Corn yields have been, and still are, above 40 bushels per acre on slopes of 23 percent, while the average yield is not much over 30 bushels per acre on similar land for the community as a whole. Bottomland yields are higher, of course. An oats yield of 90 bushels has been recorded.

Some years ago it was noted by the son-in-law, son, and neighbors that oats on the Von Arx farm lodged more frequently than oats on neighboring farms, even though the same variety were grown. The Gopher oat variety was introduced in 1915 and since its introduction, lodging of the crop has not been a problem.

Despite the fact that strip cropping has been practiced on this one farm for 61 years, and a fine community spirit has existed throughout the neighborhood, the practice has spread very slowly. A brother of Von Arx practiced strip cropping to some extent in the early days.

Wilhelm Langen, father of the son-in-law of the elder Von Arx, began practicing strip cropping 10 years after the arrival of the Swiss immigrant in the area. The few neighbors who tried the practice adopted it on a lesser scale; but in general they maintained strips that were too wide, and thus received less benefit from the practice than the Von Arx and Langen families.

Only in recent years, particularly in the last 3 years, have the neighbors become erosion-conscious and begun to adopt the device demonstrated by Von Arx.

They now seek more information concerning soil-saving practices.

In order to determine the effectiveness of strip cropping in conserving soil on the Von Arx farm, it was necessary to compare that farm's conditions with those prevailing on a similar farm on which strip cropping had not been practiced. Accordingly, a farm was selected on which cropping and fertilizer practices had been about the same as those employed on the Von Arx place, and which had comparable slopes and soil types.

The farm used for comparison consists of 200 acres, of which 87.9 acres are cultivated. The Von Arx farm of 198 acres has 84.5 acres in cultivation. It should be pointed out that more cultivated land on slopes steeper than 20 percent was found on the Von Arx farm than on the other.

The "yardstick" farm was settled by a homesteader from Massachusetts in 1862. The homeseeker desired to build a stock farm and raise purebred Hereford cattle. His sloping land was in pasture and woodland until about 1870, when he built the farmhouse and began plowing the sloping land for grain. At that time, entire fields were plowed without regard to slope, and this practice has been continued since. As in the case of the Von Arx farm, slopes up to about 30 percent were broken. When plowing, a very rough contour was followed, as a matter of necessity, because of the lay of the land along the talus slope.

The common rotation during the last 20 years has consisted of corn, small grain, and clover-timothy hay. If good stands were secured in the hay meadows, the meadows were left as such for several years. During the last few years, however, it has become increasingly difficult to obtain stands of hay. On one field corn has been grown almost continuously since about 1870; the field is relatively flat and was the first to be broken on the farm.

The predominant upland soil on both farms is a light-colored silt loam developed on silty material which is, presumably, loess. It has been mapped as No. 16 Fayette silt loam and associated series, in the soil survey of Houston County, U. S. D. A. Bureau of Chemistry and Soils, Series of 1929, No. 31. A terrace phase, Fayette silt loam No. 17, was separated where found on benches. Where sandy material was found at the surface and in the subsoil, a Boone fine sandy loam was mapped. Soils on the steep wooded slopes were grouped as No. 9, rough stony land. Bottomland soils have been grouped as No. 146, undifferentiated bottomland, and 6, Ray silt loam. Alluvial material in the upper drainageways is classed as 7, Judson silt loam, and 71, Judson sandy loam.

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Birdsfoot Trefoil—A Promising Legume for the Northeastern States

By R. E. CULBERTSON¹



Left, stems characteristic of the pasture type; center, seed pods shaped like bird's feet; right, stems of the hay type.

BIRDSFOOT trefoil as a stabilizer of gullies and road banks, and for summer pasture during periods of drought, has received a great deal of attention in New York State. It appears to have unusual potentialities for the control of soil erosion.

Birdsfoot trefoil (*Lotus corniculatus*) is a perennial legume which may live indefinitely under favorable conditions. It has a typical taproot with strong growing laterals. There are at least two kinds of plants. These have been designated as hay and pasture types. The former is upright and branched with wide leaves, while the latter is procumbent with narrow leaves. All the overground branches start from the uppermost part of the taproot or crown. Although stems have been found rooting at the nodes, this condition is not common in the field. In the procumbent type, a very heavy mat is produced, with one plant frequently attaining a spread of 6 feet.

The home of birdsfoot trefoil is in temperate Europe and Asia. It has been known in Greece from time immemorial but received little attention either in Europe or America, as an agricultural crop, until a short time before the World War.

The plant has become naturalized in several parts of the United States, notably western Oregon, and eastern New York in Greene, Saratoga, Columbia, and Albany Counties where it is hardy and persistent and is considered valuable for both hay and pasture. It has

been known for at least 50 years in the vicinity of Claverack in Columbia County, N. Y.

The plant grows well on a wide range of soils, especially those low in lime and phosphorus and subject to periods of drought. In eastern New York, birdsfoot trefoil is growing luxuriantly on soil having a pH of 4.5 to 5, in association with goldenrod, wild carrot, devil's paintbrush, redtop, poverty grass, and Canada bluegrass.

Botanical analyses made in fields belonging to one of our cooperators, L. H. Cooke of Preston Hollow, N. Y., showed the following results:

Site A: Swampy area

	Percent
Birdsfoot trefoil.....	10
Timothy.....	30
Sedge.....	20
Rush.....	10
Quackgrass.....	10
Clover.....	10
Weeds.....	10

Site B: Abandoned field, dry situation

	Percent
Birdsfoot trefoil.....	20
Goldenrod.....	20
Wild carrot.....	10
Redtop.....	10
Canada bluegrass.....	10
Poverty grass.....	15
Other weeds.....	5
Bare ground.....	10

Site C: Well cared for pasture, intermediate fertility

	Percent
Birdsfoot trefoil.....	50
Timothy.....	10
Canada bluegrass.....	10
Redtop.....	7
Weeds.....	20
Bare ground.....	3

Site D: Well cared for pasture, low fertility

	Percent
Birdsfoot trefoil.....	30
Poverty grass.....	30
Canada bluegrass.....	10
Wild white clover.....	10
Redtop.....	5
Timothy.....	3
Weeds.....	7
Bare ground.....	5

The plant, likewise, does well on highly fertile soil. It is growing profusely in the soil conservation grass nursery at Ithaca, N. Y., where the soil has a pH of 8.5.

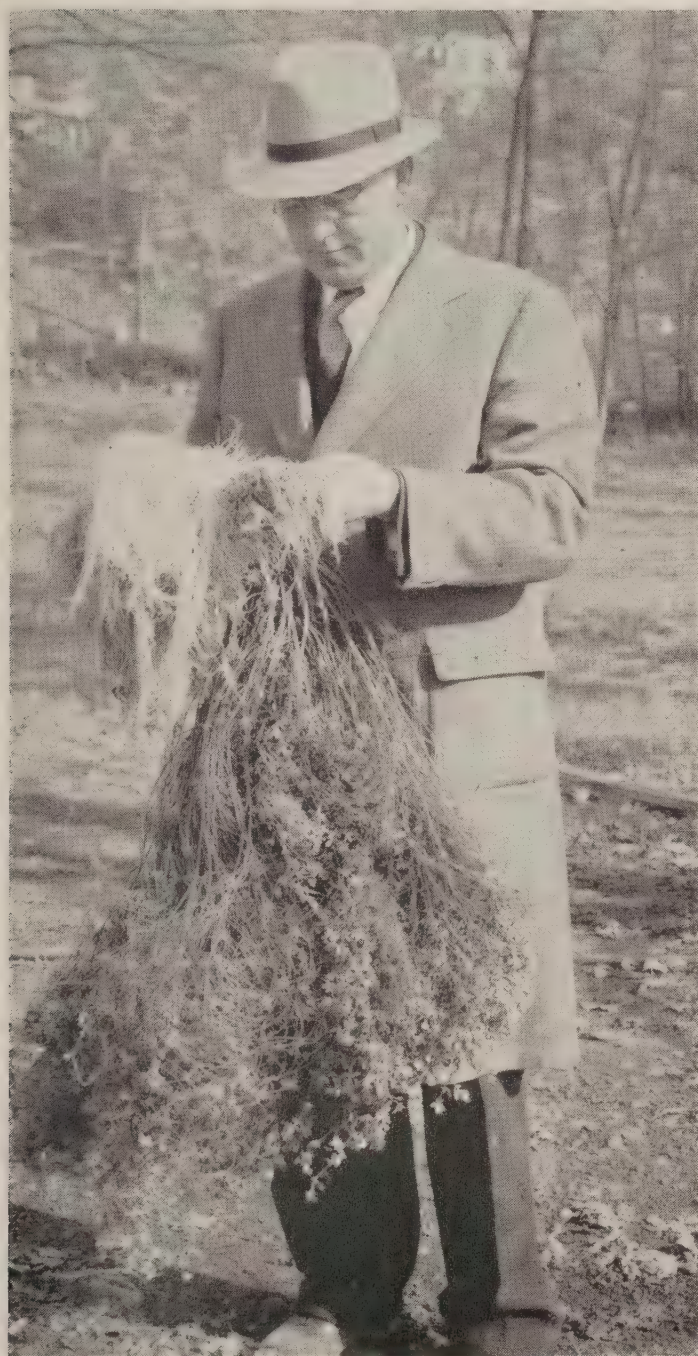
The feeding value of birdsfoot trefoil was recognized by the early Grecians who described it as a leguminous plant on which horses fed. It is highly nutritious and

¹ Manager, Soil Conservation Service grass nursery, Ithaca, N. Y.

approaches alfalfa as a feed for dairy cows. It is relished by all classes of livestock and is reported not to cause bloating.

In addition to the advantages of birdsfoot trefoil as a good soil binder and gully stabilizer, it has other advantages from the standpoint of practical agronomy. They are listed as follows:

1. It will thrive on soils of low fertility and low pH.
2. It is very drought-resistant.
3. It ranks with redtop and alsike in adaptability to wet soils, and makes good growth in areas unsuited to red clover and alfalfa.
4. It produces 2 to 3 cuttings a year and yields from 1 to 2½ tons of hay per acre.



Hay type of birdsfoot trefoil, showing root system and tremendous top growth.

5. It grows vigorously after cutting and provides excellent aftermath.
6. It is a good soil builder.
7. It makes rank growth during dry hot summers and provides abundant forage during July and August. At Cornell, during July and August a plot of Kentucky bluegrass with birdsfoot trefoil produced nearly four times as much dry weight as a plot of Kentucky bluegrass with white clover.
8. It grows late into the fall and remains green throughout the winter.
9. Animals do not like the flowers; hence, reseeding takes place naturally under pasturing conditions.
10. Hay with ripe pods may be fed to livestock and the seed spread over the pastures in the manure. Passage of the seed through the alimentary canal does not seem to affect the viability.

For successful stands of birdsfoot trefoil, inoculation is absolutely essential. The inoculant is a bacteria *Rhizobium* sp. of the Lotus group. This inoculant may also be used for kidney vetch and the winged pea.

In the latitude of Ithaca, the seed may be broadcast on the grain crop in the early spring or sown alone or in combination during April, May, or August. Fall seeding permits early spring growth and is a means of increasing the amount of pasture or hay for the first season.

For best results birdsfoot trefoil should be planted shallow, never deeper than one-half inch on clay soils and three-fourths inch on sandy soils. The amount to plant per acre will vary with the percent germination and the proportion of hard seeds which sometimes is as high as 75 percent. One pound of seed to the acre is equivalent to nine seeds per square foot. The usual rate of seeding is 1 to 4 pounds to the acre.

Until more information is gathered relative to this plant's behavior with the grasses in common usage, it appears advisable that the seed be used somewhat sparingly in seeding mixtures—in about the same proportions as white clover.

Under good growing conditions, plants from spring seeding will furnish a fair crop of hay in the early fall. Plants from fall seeding will furnish a larger amount of hay. The matter of haymaking involves no special equipment other than that usually found on the farm. Pure stands of the hay type are feasible but pasture type should be sown with ryegrass, brome grass, orchard grass, timothy, etc.



Characteristic growth of birdsfoot trefoil.



Close-up showing root penetration to a depth of 4 feet on edge of gravel pit.

There is little difficulty in harvesting the hay type of birdsfoot trefoil. In the case of the pasture type the stems are flexible and hug the ground and it is the general custom to sow with a grass such as ryegrass to induce upright growth. When grown primarily for seed, a seeding rate of 2 to 4 pounds of birdsfoot trefoil and 15 to 20 pounds of ryegrass is recommended.

The plant continues to flower and ripen seed simultaneously, so that judgment must be used in harvesting in order that the greatest possible amount of seed

be obtained. The best practice is to use the second cutting for seed.

Owing to the rapid dehiscence of the seed pods if dried in sunlight, they should be cut while still a little green. The best time of day for mowing is while there is some dew on the foliage, and this same rule applies in raking and loading. Good ventilation should be provided when drying in the hayloft.

The seed may be threshed with a regular clover huller equipped with the proper-sized screens. These are one-fifteenth of an inch for the upper and one twenty-second of an inch for the lower. Under average conditions the yield of seed per acre ranges from 100 to 200 pounds. A good seed crop will run about 100 pounds to the ton of hay.

Birdsfoot trefoil is subject to several minor diseases such as leaf spot and powdery and downy mildew, but these diseases seldom cause much damage.

The clover seed chalcis fly (*Burchophagus funebris*) is the most important insect pest. This is a small wasp-like insect, the larvae of which eat out the center of the seed leaving a round hole through which the adult emerges. Damage in the field may be reduced by

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Report of Land Retirement Operations in Southern Great Plains

By H. H. FINNELL ¹

FOR 2 or more years the Service has had 27 project and C. C. C. camp demonstration areas in operation in Region 6. During this period, 1,682 cooperative agreements have been made, and 1,159 of them

¹ Regional conservator, Soil Conservation Service, Amarillo, Tex.



1.

Leveling hummocks on a 120-acre field near Dalhart, Tex., in the spring of 1935. Cultivation, running into 2 successive years of drought and crop failure, terminated in severe wind erosion. Russian thistles pocketed sand and dirt, and the hummocks resulted. Leveling by machine was a necessary prelude to retirement of the field to permanent vegetation.



2.

Sudan grass was planted in the spring of 1935. Here's how it looked in October. The entire crop was left as winter cover and as a means of stabilizing the soil for the seeding of permanent vegetation.

(68.9 percent) contain complete data on soils. Under these 1,159 agreements, there are 262,915 acres of idle and cropland, 510,269 acres of pasture and rangeland, and 15,928 acres devoted to farmsteads, roads, waste, or miscellaneous uses, totaling 789,112 acres. The average farm for the group studied is 681 acres, with 228 acres, or 33.3 percent, in plowed land.

Agreements excluded from the study were mostly C. C. C. camp agreements which were written during the early stages of the program without soil maps adequate for an accurate classification of soils according to the problem area groups now recognized.

The method of study involved the tabulation of soil and conservation-plan data for each field designated in the agreements. This included broad classifications of soils and adjusted land uses, by individual tracts, for approximately 6,000 fields and pastures. The data are organized in such a manner as to permit studies according to land uses, projects, problem areas or single units. It is proposed to give here only a brief regional summary of the land-retirement experience in the Southern Great Plains demonstration areas. Table 1 shows the problem area grouping of the plowed land portion of the 1,159 units.

The general recommendations of the regional office, covering the possible land uses to which areas of these

various descriptions may be properly devoted under approved conservation practices, recognize as suitable for cultivation all lands classified under problem area groups 1, 2, 3, and 5, and approximately one-half of those already under cultivation in problem area 4. They recognize for grazing utilization, problem area groups 6, 7, 8, and 9; for grazing and/or forest utilization, problem area group 10; and, preferably for grazing utilization, all of problem area group 4 that is in grass, and approximately one-half of that which has been plowed.

An analysis of the plowed land area shows that 43,805 acres, or 17 percent of the total cultivated area, consist of problem area groups not recommended for cultivation. It is certain that some of the lands classified in problem area groups 4 and 6 might, at the time they were placed in cultivation, have been described under problem area groups 2, 3, or 5; but later, when conservation plans were prepared, these lands were found to be in a condition unfit for future cultivation because of the accelerated erosion resulting from abuses and neglects.

With this interpretation in mind, it should be pointed out that the farmers who developed these 1,159 units were somewhat better than 83-percent correct in their original choice of soil types for plowing.

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Table 1.—Soil grouping of the plowed land area of 1,159 farms under agreement in the Southern Great Plains region

Problem area group No.	Soil characteristics	Acres plowed land	Percentage of total plowed land
1.....	Alluvial.....	5,849	2
2.....	Deep, moderately heavy.....	129,624	49
3.....	Deep, moderately sandy.....	29,488	11
4.....	Medium depth.....	30,100	11
5.....	Deep, sandy.....	27,634	11
6.....	Shallow depth.....	22,927	9
7.....	Loose sand.....	4,244	2
8.....	Very heavy clay (shale origin).....	740	—1
9.....	Rough, broken and stony.....	516	—1
10.....	Mountain.....	323	—1
	Unknown.....	11,470	4
Total.....		262,915	100

Table 2.—Land-use adjustments on 1,159 farms under agreement in the Southern Great Plains region

Kind of change	Purpose of change	Acres changed	Percentage of total land use changed
Cropland to permanent vegetation.....	Erosion control.....	16,077	48.6
Do.....	Farm management.....	16,737	50.6
Pasture to cropland.....	do.....	240	.8
Total.....		33,054	100.0



3.

Grasses, largely blue grama, in the fall of 1937. The grass was seeded with a drill in May. Due to the furrows and cover formed earlier by the Sudan, most of the vegetation sprang from the rows where the Sudan had grown. Other parts of the field did not show such a good coverage as this spot, but a fair cover was secured over most of this retired field.



4.

The same field in the fall of 1938.

Conservation recommendations of the Service in this region are based upon the physical and economic inventories of the individual farm units concerned. Land-use changes, including retirement of land from cultivation to pasture, meadow, or woodland, and the changing of tracts of land from permanent vegetation to cultivation, should be made upon the basis of both the physical and economic needs of the farm unit. Any exceptions to this general rule must be justified by economic needs of the operator, if they are of such significance as to outweigh other considerations. Typical examples of changing land use in the Southern Great Plains region may be enumerated as follows: (1) Changes from cultivation to pasture because of inferior soil; (2) changes from cultivation to pasture because of erosion damages to the soil; (3) changes from cultivation to meadow because of production needs of the farm unit; (4) changes from abandonment to permanent vegetation because of erosion damages to the soil; and (5) changes from cultivation to permanent vegetation because of lack of balance in the farm unit. Wherever any of these changes are needed, exceptions should become necessary only because of inconvenient location of tracts, water supply, or other circumstances that may make the needed change impractical from an operating point of view. It frequently develops that needs arising from physical land conditions are contrary to the economic needs of the farm unit, and vice versa. In such an instance, it may be necessary to work out a compromise that best fits the individual situation.

Summarized land-use adjustments have been provided for in the 1,159 agreements analyzed, as shown in table 2.

Cultivated land which normally would be recommended for retirement but which was continued in cultivation because of other considerations requiring a compromise, has been classified in table 3.

Flexibility in land-use determinations involving problem area groups 1, 2, 3, and 5 is desirable from the standpoint of economic choice, since erosion control on

these areas may be satisfactorily achieved through safe practice alternatives and does not require unusual skill on the part of the operator. In problem area 4, soils are productive under favorable seasonal conditions, but the hazard of drought is generally greater than in other tillable problem areas; hence, indiscriminate use for crop production is unduly hazardous. Only the most dependable types of crops are recommended for the major crop enterprises on this land, and it is recognized that skill in management of soil, water, and the crop is necessary under these conditions. In problem areas 6 and 7, unusual consideration of location or economic needs is required to justify keeping land in cultivation, and little variation from the most rigid erosion-control practices is permissible.

Of the 43,805 acres of cultivated land indicated in detailed surveys as not recommended for cultivation, 16,077 acres were retired, 3,078 acres were left in cultivation because the location of small tracts made it impractical to convert the land to permanent vegetation, and 13,947 acres were left in cultivation because of economic necessities derived from such considerations as size of unit, type of equipment, available labor, market facilities, crop diversification or balance between farm enterprises. This leaves 10,703 acres, or 24.4 percent, remaining in cultivation without apparent justification. It is quite possible, of course, that valid reasons for some of these exceptions may exist, but they were not indicated in the conservation plans.

A classification of the 27,728 acres of land not recommended for cultivation but which, under agreement, remain in cultivation for various reasons, is shown in table 4.

Soils of problem area group 4 may be safely kept in cultivation under sound farm unit organization with appropriate erosion-control practices. Since it has been demonstrated that it is possible, by means of special precautions, to retain soils of problem area groups 6 and 7 in cultivation (although generally undesirable from the standpoint of physical problems) there remain 941 acres (groups 8, 9, and 10), or approxi-

Table 3.—Land-use changes compromised on 1,159 farms under agreement in the Southern Great Plains region

Change indicated as needed	Reason for continuing in cultivation	Acres compromised	Percentage of total acres compromised
Cropland to permanent vegetation.....	Inconvenient location.....	3,078	11.1
Do.....	Farm management requirements.....	13,947	50.3
Do.....	None found.....	10,703	38.6
Total.....	.....	27,728	100.0

Table 4.—Problem area grouping of soils recommended for retirement but for various reasons not converted

Problem area group No.	Acres	Percentage of total
4.....	8,835	31.9
6.....	15,647	56.4
7.....	2,305	8.3
8.....	470	1.7
9.....	264	1.0
10.....	207	.7
Total.....	27,728	100.0

mately 2 percent of the inferior land in cultivation which cannot be justified on any conceivable grounds.

Interpreted in terms of the quality of job done by the technicians of the Service, with respect to retirement of submarginal land, it is indicated that 75.6 percent of the most desirable land-use adjustment has been realized, and that 98 percent of that required by absolute physical necessity has been achieved.

On a small farm in Washington County, Mo., a Soil Conservation Service cooperator gets \$68 a year for raccoon, mink, fox, skunk, and opossum pelts.

Another cooperator in western Pennsylvania has obtained an average annual income of \$70 to \$100 for skunk, mink, muskrat, and opossum hides from 360 acres.

STRIP CROPPING IN BUSH V

(Continued from p. 241)

Erosion conditions, along with land use, slopes, and soils are much the better on the Von Arx farm. On the "yardstick" farm, parts of two fields had been tiled, the tile being laid 4 feet deep. Recent digging has shown the tile to be 7 feet below the surface of the ground at the present time. This indicates that 3 feet of silty material has been deposited on the fields.

Particularly noticeable is the lack of field gullies on the Von Arx farm as compared with the large number of gullied fields on the other property, where entire slopes were plowed.

BIRDSFOOT TREFOIL

(Continued from p. 244)

pasturing or making hay of the first crop and saving the second crop for seed.

Newly harvested seed should be examined frequently and in case flies are present they may be killed with carbon disulfide. Satisfactory results may likewise be secured through the use of paradichlorobenzene.

Birdsfoot trefoil is giving good results in the soil erosion program of the Northeastern States, but additional information concerning the adaptation of this plant must be secured before it can be widely used.

HIGHWAY EROSION CONTROL IN SOIL CONSERVATION DISTRICTS

By Arnold M. Davis¹

A COMPLETE erosion-control plan for each field on a farm requires that the problem be considered beyond the boundaries of the farm. In some instances the problem extends to other farms. Again, it extends to the highway or service roads adjoining the fields. In all cases, it is necessary to consider the run-off and the erosion on adjoining roads in order to develop a successful and complete erosion-control plan on the farm.

In June 1936, the Service established the policy of cooperating with the various State highway departments and the Bureau of Public Roads of the Department of Agriculture to demonstrate economical means for controlling erosion on the primary highways in

the United States. An effort was made to cover as many problem areas as the available labor and technical assistance permitted. The purpose of these demonstrations was not only to determine effective highway erosion-control measures but also to demonstrate their practical application on a field scale. It was necessary to improve many old highway slopes, to facilitate adequate erosion control, and determine the most suitable form in which successful farm erosion-control practices could be adapted to highway work. It was also necessary to develop the most successful correlation between highway erosion-control practices and those on adjacent farm lands. Once the most successful measures and procedures could be determined and demonstrated, their introduction into

¹ Agricultural engineer, section of engineering, Soil Conservation Service, Washington, D. C.

original construction plans would have wide application. This work is now known in the Service as a "highway demonstration program."

Soon after the inauguration of this cooperative work, it was decided to extend to the county road officials our willingness to cooperate and assist them in controlling erosion at critical areas on county roads when these areas bordered on a farm under cooperative agreement with the Service. This type of work is known in the Service as "protective highway erosion-control work." Its development resulted in a full realization that the most complete and successful farm erosion-control plans could not always be developed without effective cooperative efforts between the landowner and the officials charged with the responsibility of maintaining the public roads. It is intended that the direction of this phase of erosion work will be taken over by the supervisors of legally constituted Soil Conservation Districts when they become organized. The Service will furnish the board of supervisors with technical assistance and available labor just as they are furnished for regular erosion-control work on agricultural land.

The Service's cooperation in this particular phase of the work is limited to such highway activities as are necessary to facilitate satisfactory erosion-control practices on the adjacent farm land. For instance, if a road ditch can be used for a terrace outlet channel, it is often less expensive, at least no more expensive, to repair and treat the road ditch for this purpose than it is to excavate and treat a parallel outlet on the land adjacent to the highway. When the road ditch is used and properly treated, the highway is benefited as well as the farm run-off disposal system. Cooperative efforts of this type eliminate duplication and provide a more stable outlet system. It is obvious that a parallel ditch on the farm would not be perma-



*Erosion on the highway right-of-way spreads to the adjoining fields. Cure it by—
Revising the cross section and establishing a permanent cover on the exposed area.*



nent if placed along a badly eroding highway ditch. Likewise there are many places where the road ditches or poorly constructed culverts have caused gullies to encroach into the farm land, and in some instances the highway banks have sloughed off and caused damage to farm property—fences, buildings, etc. There is a problem also where the soil which is eroded from the highway ditch is deposited on good bottomland. All such conditions necessitate treatment of the road ditch in order to develop permanent and complete farm erosion-control plans.

In the semiarid section of the United States, the water collected by road ditches can often be utilized to advantage by the adjacent landowner. Properly constructed intercepting terraces that tie into the road embankment will divert the surplus water to the adjacent land. This practice not only will help to prevent erosion on highway right-of-ways, but will improve the moisture conditions of the adjoining pastures or cultivated fields. This additional moisture often assures a profitable crop return where there would otherwise be a failure. All highway or



The highway ditch can be used as a terrace outlet channel when conditions are similar to those shown here.



Good hay has been obtained from the highway right-of-way.

cooperative erosion-control measures on adjacent land will be visible to the automotive traveling public and should tend to make them erosion-control conscious. When applied on a large scale this educational aspect alone will accomplish a great deal towards the development of a national erosion-control program.

Since highways are constantly being relocated or improved as traffic requirements change, it is necessary that due consideration be given these requirements in the preparation of the initial plans for establishing any erosion-control measures on roads or highways. If these are not considered, established erosion-control practices are likely to be destroyed when roadbed or roadway improvements are undertaken. Highway erosion-control measures must be established in connection with roadway cross sections likely to be required to facilitate safe, efficient traffic and subsequent maintenance operations. The providing of well-coordinated plans at the outset will assure satisfactory roadways, erosion control, and maintenance with a minimum expenditure of efforts and funds.

Most of the legally constituted soil conservation district work-plans contain provisions for cooperating with the county or State highway departments to

assist in controlling erosion on road and highway rights-of-way. It is expected that the districts will continue this work in a manner similar to the procedure formulated by the Soil Conservation Service and that, with the technical assistance of the Service, the

districts will be able to secure a much wider application of this type of work. An extensive application of this work, especially on critical highway areas, will in time reduce the maintenance cost of county roads. This makes it possible to divert more of the county funds to the development and improvement of farm-to-market roads, which, in turn, should be a general benefit to the entire community.

The Soil Conservation Service has recommended the forms to be used by the districts when cooperative highway erosion-control work is contemplated. If the district supervisors adopt the use of these forms for this cooperative work and agree to cooperate with the various highway officials in solving this problem, the Service technicians assigned to the districts will be able to carry on the protective phase of the work through the district program. In the end this work should prove to be very beneficial to the program of soil and moisture conservation on agricultural land. The control of erosion on agricultural land is the district's as well as the Service's major responsibility, but properly planned cooperative work with road officials will facilitate the final accomplishment of this goal.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



NATIVE WOODY PLANTS OF THE UNITED STATES, THEIR EROSION-CONTROL AND WILDLIFE VALUES. By William R. Van Dersal. U. S. Department of Agriculture Miscellaneous Publication No. 303. Washington, D. C. June 1938.

This volume is far more than a list. It is a careful study of native woody plants, their growth characteristics, and their value to man and wildlife. It is, in particular, an excellent reference for anyone seeking information regarding woody species for erosion-control plantings and wildlife habitats. Undoubtedly, the emphasis is upon plants for wildlife food and cover, as the descriptions contain what is known about wildlife utilization of woody species native to all of the United States except the subtropical portion of Florida.

As for woody plants for erosion control, all conservationists know that it is not merely a matter of sticking in a plant here and a plant there: We must know where and on what soils a species will grow, under what drought or moisture or temperature conditions it will thrive, its root and stem systems, insects and diseases to which it is susceptible, its aggressiveness, its relation to other species and to the soil, its food or other value, and many other things about it. And, the problem is further complicated when we know that the plantings must be a mixture, not a pure stand.

It is here that such a ready reference as *Native Woody Plants of the United States* comes in; for the objectives and the organization of the book are carefully explained by Mr. Van Dersal in his Introduction, and with the fine maps which accompany the volume, the user of the list should have no difficulty in evaluating woody species for erosion-control and wildlife plantings. The first map shows the 32 plant-growth regions of the United States. The second map shows the plant-growth regions superimposed upon the 23 climatic provinces. The third map shows the 32 plant-growth regions superimposed upon the 50 soil regions. The climatic provinces are by Thornthwaite, the plant-growth regions by Furman Lloyd Mulford of the Bureau of Plant Industry, and the soils regions by the Bureau of Chemistry and Soils.

Turning to the list we find that of the 1,780 woody species of the United States, 1,522 of them are described as to range, site designation, growth habits, fruiting, propagation, and utilization by wildlife. The remaining 260 or so species are not included because they are plants upon which there is no agreement by taxonomists. The items are arranged alphabetically by Latin names, and all important synonyms are included so that the desired species may be readily found. Vernacular names are given where the species bears one that is distinctive.

Known utilization of woody species by wildlife is presented under the special headings "Stomach records" and "Observations." Under the former heading are placed all records of utilization based on examination of stomach contents, and under the latter those obtained from the literature.

Mr. Van Dersal's book has been in use now for some months and has been found particularly valuable in compiling lists of important timber species, woody species of value to honey bees, wildlife plantings; and, by careful testing of plant characters as given in the descriptions, erosion-control species may be sorted out and classified as to their special and various places in the soil conservation planting program. The book contains an excellent list of common names of woody plants, and an extensive bibliography.

WILDFOWL FOOD PLANTS, THEIR VALUE, PROPAGATION, AND MANAGEMENT. By W. L. McAtee. Collegiate Press, Ames, Iowa. 1939.

This volume is being hailed with commendatory cheers by those who know the true facts about the American waterfowl crisis. Some whose signatures occupied prominent places in the pages of the March issue of *SOIL CONSERVATION* have told me that the beautiful little volume is not only beautiful but is the "last word" concerning proper food plants for waterfowl. And in addition it opens the door to means by which the plant may be fitted to the site for the preservation of sadly depleted flocks that come winging their way to the hundreds and thousands of ponds and lakes lately created by the water conservation program, and to the State and private refuges.

Everyone knows W. L. McAtee as the man from the United States Biological Survey who for 30 years has been traveling up and down the continent observing and collecting wild ducks, geese, and swans and their food plants. Some may not realize, however, that as long ago as 1905, Mr. McAtee began making laboratory food habits studies of these birds and that throughout the years he, more than any other person, was responsible for the accumulation of data which grew in volume and value and went into the making of this and other thoroughly authoritative works.

Apparently the author has chosen his material chiefly with an eye to the most useful and authentic information; *Wildfowl Food Plants* is a very compact book, with not an unnecessary word in its text, and it is so arranged as to make it extremely convenient for ready reference. Chapter I, "Productivity, value and utilization of wildfowl food plants," covers only 5 pages, but it is quite enough to show us the importance of 10 aquatic plant families in the subsistence of 12 of the more common species of wild ducks. Chapter II, which is half the book to the index, treats of the important wild duck food plants, arranged in the systematic order of families, and including innumerable notes on their variety and habit of growth, their ecology, and their utilization by the various waterfowl. About 30 plant families are so treated, and 1 order, the algae; certain individuals of other families, as the cattails, arums, scouring rushes, pickerel weeds, bloodworts, lizard's-tail, walnuts, bayberries, crowfoots, and loosestrifes, are mentioned also as providing a measure of subsistence to 1 or 2 of the ducks. The pondweeds, sedges, and grasses appear to be the most important to the waterfowl of all plants.

A most useful part of the book to the small water facilities technicians and the wildlife managers of the Service is the chapter dealing with the environmental limitations on the growth of aquatic plants—fitting the plant to the site.

Another very workable chapter deals with planting methods. Here is found in full force the author's talent for presenting an immense amount of valuable information within a small space—in a page and a half he gives directions as to the material to be used in transplanting 55 different groups of aquatic plants.

The final three chapters deal with the construction of ponds for various sites, the control of undesirable plants and animals in water areas for wildfowl, and vernacular names of wildfowl food plants. There is a bibliography containing 37 titles and an extensive index to the volume.

Seven Soil Conservation Service Publications Fresh Off the Press

For **REFERENCE**
Compiled
by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Survey of Barcroft Reservoir, Alexandria, Va., September 17, 1937-March 8, 1938. mm. SCS-SS-29. January 1939.¹

Advance Report on the Sedimentation Survey of Burlington Reservoir, Burlington, N. C. (In cooperation with the North Carolina Experiment Station.) April 16-May 21, 1938. mm. SCS-SS-28. December 1938.¹

Soil and Water Conservation Investigations. Progress Report of the Central Piedmont Soil and Water Conservation Experiment Station, Statesville, N. C., 1930-35. (In cooperation with North Carolina Agricultural Experiment Station.) mm. SCS-ESR-6. October 1938.¹

Soil and Water Conservation Investigations. Progress Report of the Blackland Soil and Water Conservation Experiment Station, Temple, Tex., 1931-36. (In cooperation with Texas Agricultural Experiment Station.) mm. SCS-ESR-7. December 1938.¹

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A Study of Some of the Older Strip Cropping in Ohio, Pennsylvania, and West Virginia. mm. SCS-TP-20. January 1939.¹

Office of Information, U. S. Department of Agriculture

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How to Keep and Increase Black Grama on Southwestern Ranges. Leaflet 180. Forest Service. January 1939.

Land Facts on the Southern Plains. Miscellaneous Publication 334. Soil Conservation Service. 1939. 30c.²

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Geographic Distribution of Arkansas Crops and Livestock. Bulletin 367. Agricultural Experiment Station, Fayetteville, Ark. November 1938.

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Some Trends in Utah's Agriculture. Bulletin 286. Agricultural Experiment Station, Logan, Utah. January 1939.

Spring and Winter Wheat Varieties Under Irrigation. Bulletin 365. Agricultural Experiment Station, Bozeman, Mont. December 1938.

A Study of Farm Organization by Types of Farm in Uinta Basin, Utah. Bulletin 285. Agricultural Experiment Station, Logan, Utah. January 1939.

Thirty Years of Soil Fertility Investigations in South Dakota. Bulletin 325. Agricultural Experiment Station, Brookings, S. Dak. June 1938.

Types of Farming in Iowa II. Bulletin 374. Agricultural Experiment Station, Ames, Iowa, in cooperation with U. S. Department of Agriculture. August 1938.

Miscellaneous

An Economic Study of Farming in the Crooked Creek Area, Indiana and Armstrong Counties, Pennsylvania. Bulletin 369. The Pennsylvania State College, School of Agriculture and Experiment Station, State College, Penn., in cooperation with the U. S. Department of Agriculture. November 1938.

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The Improvement of Grass Land. Bulletin 3, Ministry of Agriculture and Fisheries. 1s. 6d. net from His Majesty's Stationery Office, Adastral House, Kingsway, London, W. C. 2. 1937.

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Potatoes and Soil Erosion. Circular 131. Agricultural Extension Service, University of Maine, Orono, Maine, in cooperation with Soil Conservation Service, U. S. Department of Agriculture. February 1939.

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Special Agricultural Investigations: A preliminary report of research authorized by the Oregon Legislature, 1937 session. Station Circular 130. Oregon State System of Higher Education, Agricultural Experiment Station-Federal Cooperative Extension Service, Oregon State College, Corvallis, Ore. December 1938.

¹ Issued for use by Soil Conservation Service staff and cooperating officials only.

² From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

TRANSITION OF A GULLY

DRAWN FROM PHOTOGRAPHS TAKEN IN NEW JERSEY



RESULT OF 6.26"
RAINFALL.

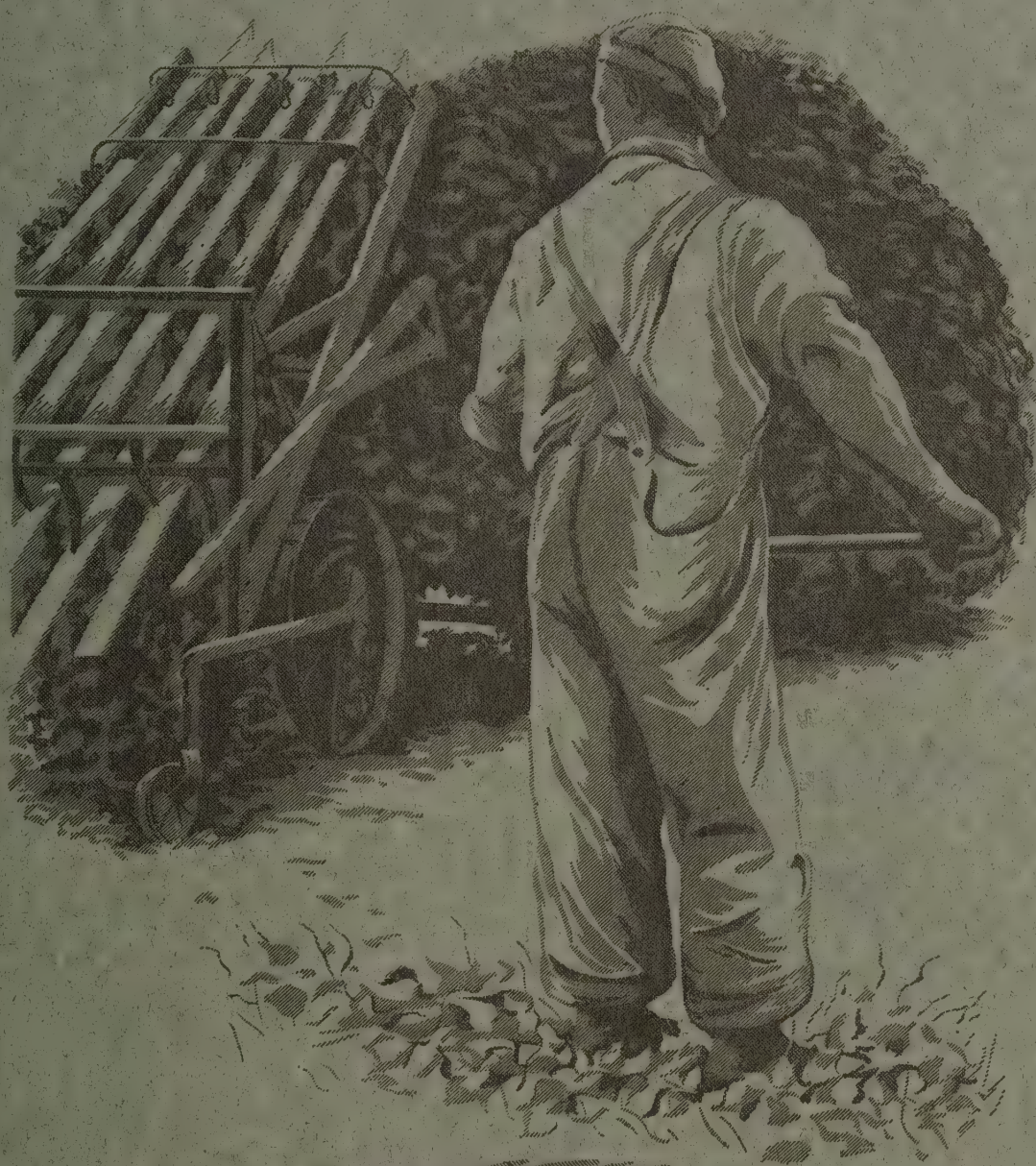
SAME FIELD THREE
MONTHS LATER



SAME FIELD IN
PROCESS OF
CONSERVATION.
Banks sloped and
just planted to honey-
suckle.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON



May 1939

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WELLINGTON BRINK
EDITOR

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SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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Evaluating Our Practices on Demonstration Projects

By R. E. Uhland ¹ and W. F. Peel ²



1. Havoc caused by torrential rain of 7.1 inches where fields were not protected against run-off and erosion.

THE RAPID expansion of the work of the Soil Conservation Service throughout the United States naturally called for the use of many erosion control practices before they had been thoroughly tested under the varying conditions found on the many project areas. Our Service personnel have, from the very beginning, felt the urgent need for further study and evaluation of the effectiveness of our practices when

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² Senior soil conservationist, operations division, Washington, D. C.



2. Hundreds of tons of soil were carried on to highways. Expense for removal was heavy.

applied in different parts of the United States. From the time the first demonstrations were started, general observations were made to determine whether or not the control measures were effective. As a result of these experiences, a number of practices and procedures were eliminated or materially altered. We refer particularly to the wide use of large and expensive structures and equipment which were found to be out of place on the average farm in that the proper use of vegetation proved more effective and economical.

Early in 1937, a systematic procedure was initiated by the research and operations divisions of the Soil Conservation Service, in cooperation with the State



3. There was no erosion following a torrential 5-inch rain on strip-cropped fields supplied with grassed waterways.

experiment stations, for evaluating the practices on the different project areas. The objectives of these evaluation studies were, first, to determine the effectiveness of different erosion-control practices or combination of practices; second, to provide facts to aid in improving these practices and in formulating plans for their extension; third, to delineate problems requiring research methods of solution and to present them to the proper research agencies for consideration; fourth, to assemble pertinent information for use

in connection with the preparation of project monographs; fifth, to further the dissemination of information on our soil conservation work in the field, particularly among cooperating agencies.

In order to ensure the proper planning for the conduct of evaluation surveys and field tests and thereby meet the above objectives, a standardized procedure was set forth in Field Memorandum SCS-553. This procedure called for the development of detailed working plans covering the evaluation of different erosion-control practices or, in some cases, phases of these practices. These plans set forth the objective of the study and give the detailed procedure to be followed in carrying out the studies.

The steering committee for each State assists in the development of these plans, particularly of the technical procedure. The plans are reviewed and approved by the members of this committee, which consists of the regional conservator or his representative, a designated representative of the division of research in the field, and the director of the State experiment station or his representative, before they are submitted to Washington for final approval. In the development of these plans, advice and assistance of the experiment station staff and the regional and project technicians are solicited.

The evaluation surveys provide for the systematic recording, by the project technicians, of pertinent facts concerning these different erosion-control measures already installed on the farms. The procedure followed in evaluating our soil conservation practices on demonstration projects is divided into three stages, namely, (1) general observations; (2) detailed studies; and (3) field tests. The field observations made on practices already in use on the farm supply information of a general nature as to whether or not the soil and moisture conservation practices have been successful. More detailed studies must be resorted to, covering selected farms, to determine the factors contributing to the successes or failures. When these two procedures fail to give the necessary information, planned field tests are established under controlled conditions. This procedure makes it possible to give quantitative expressions to the relative effectiveness of varying practices and furnishes the information needed for their improvement. The initiation of field tests is delayed until their need has been definitely determined. These field tests furnish practical and effective demonstrations and make possible the collection of data so necessary for the improvement of field measures and practices for controlling erosion.

The procedure to be followed in analyzing, reporting, and publishing data on evaluation surveys and field

tests was supplied in Field Memorandum SCS-727. Among other things, an annual report covering the findings from these studies is required at the end of each calendar year. In addition to this, however, special and timely coverage is to be given to critical storms, whether rain or wind. This makes it possible to make immediate use of these data and the annual report provides for the recording of any changes that are found necessary in the objective, methods, and procedures pertaining to the conduct of the work.

Timely observations of the effectiveness of vegetation in lessening erosion were recorded as a result of our surveys in California following the floods last spring. Studies in the Northwest, as well as in the Northeast, show the effectiveness of trash or straw left on the surface as a mulch in increasing water penetration and preventing both wind and water erosion. These studies are supplemented and substantiated by the cooperative research findings of the Service and the State experiment station at Lincoln, Nebr. Their preliminary findings show that the application, to the surface, of 2 tons of wheat straw per acre prevented any run-off, even though an inch and a half of artificial rain per hour was applied for 10 hours. Where no straw was added, or where the straw was incorporated with the soil, considerable run-off was recorded after the first hour. The same was true where basin listing was practiced. Water-penetration studies, where similar treatments were studied under normal rainfall, showed much deeper and more rapid penetration under the straw mulch than for any of the other treatments.

As a result of our experiences and studies in the northern Plains, ways and means are being developed for getting satisfactory stands of grasses economically. Contour furrows are proving quite effective in conserving water and providing a much denser cover of range grasses in both the Northern and Southern Great Plains.

An analysis of data secured on our project at Dadeville, Ala., following heavy rains in March and again in July, shows that, on the Cecil soils with slopes averaging 8 percent and having a good cover, the soil that was moved from the terrace interval into the terrace channel amounted to less than 4 tons per acre. With a medium cover, the moved soil was 14 tons per acre as compared to 54 tons of soil found in the terrace channel where the land was occupied by cotton or corn and farmed on the contour. Similar data from South Carolina show that the amount of soil moved into the terrace channel, where oats occupied one-half the terrace interval and corn or cotton the other half, was less than one-fourth that found where the



4. In the summer of 1938 a torrential rain fell on freshly worked soil. On the right hand side of the road terracing combined with strip cropping saved the fields. On the left hand side, serious gullying.

latter crops occupied the entire interval. It was found that close-growing vegetation greatly reduces the number of rills (indicating sheet erosion), the amount of soil deposited in the terrace channel, and the number of breaks in the terrace ridge.

A single rain totaling 7.1 inches was recorded on a portion of the Lancaster, Pa., project on June 27 and 28, 1938. Approximately 4.5 inches of this rain fell within an hour's time, and the maximum intensity reached 6 inches per hour for a 15-minute period. The havoc caused on cultivated land by this torrential rain is shown in photograph No. 1. Extremely heavy losses of soil, especially from unprotected slopes, resulted from this single rain. Bridges were washed out and highways seriously damaged (photographs 1 and 2). Photograph No. 3, on the other hand, shows that where fields were in sod crops or where they were strip-cropped with sod crops occupying alternate strips on the contour, very little damage resulted. At Ralston, Nebr., the effectiveness of terracing combined with strip cropping, as shown in photograph No. 4, was demonstrated when a torrential rain fell on freshly worked soil in the summer of 1938.

Results from the New York Experiment Station at Geneva, covering a very similar rain as to intensity and measuring 4.5 inches, which fell in 12 hours, illustrate the extreme losses to unprotected land when subjected to excessive rainfall. In round figures, it was found that on fallow land 66 percent of the total rainfall was lost as run-off which carried with it 46 tons of soil per acre. This was on a Dunkirk soil representing a slope of 5 percent. Corn, grown under the same conditions as to slope and type of soil and cultivated on the contour, allowed but 28-percent loss of rainfall as run-off accompanied by 8 tons of soil per acre. Likewise, red clover allowed a loss of only 5.5 percent of rainfall and 89 pounds of soil per acre, while

the loss from land in grass was less than 1 percent with but 10 pounds of soil.

These examples represent only a few scattered illustrations of the type of information we are getting from these evaluation surveys and field tests. Our project areas serve as excellent laboratories, and there is every reason to believe that the information secured as a result of these studies will help in improving and extending our soil conservation program. The need for continuing this work and extending it to some of the newly established soil conservation districts is quite apparent. Since the proper use of land calls for the application of practices based upon the particular needs and adaptability of the different soils, it is necessary that we have information on the limitations of different soil conservation practices so that adaptations may be made to meet the special needs of the lands in different areas.

Construction work is practically completed on the installation of 20 small watershed run-off studies. Each of these watersheds is made up of several unit watersheds comprising different acreages, slopes, and vegetative cover. A variety of soil types and rainfall conditions is also included as a result of the wide distribution of the studies. Records of run-off can now be secured that will materially aid the engineer in estimating flood flow to be used in the design of conservation structures. Other technicians will also be interested in this information since water erosion is directly related to run-off, and a knowledge of run-off conditions and factors is essential for the best soil treatment and vegetative adaptation.

Contour tillage is fundamental to a sound erosion control program.



The complete orchard layout includes not only soil and water conservation and a water disposal system, but also such practical devices as orchard roads, etc.

Contour Planting and Terracing as a Basis for Soil and Water Conservation in Orchards

By John T. Bregger ¹

FRUIT growers as a class have been very careful about selecting favorable sites for their orchards and vineyards, at least from the standpoint of good soil and air drainage. This very situation, especially when accompanied by prolonged cultivation so common in the case of certain stone fruits, has brought about an excessive erosion problem. In fact, it constitutes the most serious erosion problem found in some agricultural areas today; it not only cuts yields and the productivity period of the existing plantings, but destroys the sites at least temporarily for the next orchards or field crops which might follow.

The contour planting and terracing of vineyards—if not of orchards—is an Old World practice going back for several centuries in some locations. In America it is not clear just when the first contour planting of vineyards or orchards occurred. Undoubtedly there were numerous small plantings on or near the contour made by the early settlers from certain foreign countries where this practice had been in vogue. It was not until almost 1900, however, that any sizable

acreage large enough to be called “commercial” was planted on terraces or “on contour.”

Although no accurate survey has yet been made over the entire United States, the present area of contour fruit plantings is close to 40,000 acres. South Carolina alone accounts for about 15,000 acres of this total. By regions, the approximate 1938 acreages of contour orchards, in Soil Conservation Service demonstration areas alone are as follows:

	Acres
Region 1 (12 Northeastern States).....	400
Region 2 (7 Southeastern States)..... ¹	3,050
Region 3 (Michigan, Indiana, Ohio, Kentucky, Tennessee).....	300
Region 4 (Arkansas, Louisiana, Texas)..... ¹	1,500
Region 5 (Illinois, Iowa, Minnesota, Missouri, Wisconsin)..... ¹	200
Regions 6 to 9 (Prairie and Rocky Mountain States).....	75
Region 10 (California, Nevada)..... ¹	13,200
Region 11 (Idaho, Oregon, Washington)....	25
Total.....	18,750

¹Not wholly confined to young orchards laid out by Soil Conservation Service technicians.

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Because of the variation in rainfall, slope, soil, and other conditions in the different sections of the country, various types and systems of orchard terraces are in use at the present time.

First of all, terraces may be differentiated on the basis of grade. In general there are three types—level, diversion grade, and irrigation grade. The first type is invariably in use where complete conservation of rainfall is desired and will not be unduly dangerous. This may be the case in apple orchards where a permanent vegetative cover is maintained or in sections where semiarid conditions prevail. Level terraces are also adapted to short rows and where a well-drained or porous soil, with or without auxiliary protection, decreases the likelihood of over-topping under heavy rain.

The diversion grade terrace is the type most commonly used in the humid sections, particularly for cultivated orchards where the tree rows are rather long. Diversion grade terraces may vary from practically level to 1 percent in fall, depending upon length and soil factors. In most orchard areas these grades approach as nearly as possible the upper limit where scouring occurs. In the irrigation grade terrace, the use of which is almost entirely confined to California at the present time, the fall will run up to about 3 percent. Such terraces also serve as diversion terraces during the rainy season, at which time the presence of orchard cover crops slows up the rate of flow and usually prevents damage by scouring.

Diversion terraces have been occasionally installed in existing square-planted orchards largely as a makeshift practice to protect long slopes from the damaging effects of excessive and concentrated run-off. In addition to making the cultivation problem more complicated, this practice usually involves the removal or sacrifice of from 3 to 10 percent of the trees, but it has seemed more than justified on the basis of increasing the productive years of the orchard, as well as preserving the site for the next crop or orchard which will follow. In the English walnut orchards of western Oregon where the planting distance is much greater, the use of diversion terraces or ditches is often accomplished without sacrificing any trees whatever. Along this line it might be added that the use of temporary ditches (smaller and at closer intervals) is proving a very satisfactory method of preventing destructive erosion from the winter rainfall of that climatic area. These ditches after serving their purpose during the rainy season are cultivated out in the spring to be reconstructed the following fall about the same time the annual winter cover crop is sown.

From the standpoint of shape or cross-section, orchard or vineyard terraces may be characterized as bench, narrow-base, or broad-base types. The bench terrace is the normal type where the slope is above approximately 15 percent. On slopes less steep than that, terraces may be termed "narrow-base" or "broad-base," depending upon their width or cross-section. In general the narrow-base type (with a 4- to 6-foot ridge) is most common for orchard use, although the broad-base type is used occasionally where the spacing or interval approaches 100 feet as it does where only each fourth or fifth tree row is terraced. Such terraces may be as wide as 40 feet from the top of the back slope above the channel to the bottom of the down slope below the terrace ridge.

When it comes to the matter of terrace construction there are also some variations worthy of mention. In the first place, terraces have been constructed before as well as after the planting of the contour orchard. This difference has considerable significance as it determines to a large extent whether the trees will be planted on the terrace ridges or whether the ridges will be built slightly above the tree rows and gradually or more rapidly bury the tree roots on the uphill side. When large terraces are constructed prior to planting there may be a rather incomplete mixing of topsoil and subsoil which may or may not affect tree growth. When terraces are built in a gradual process as a result of contour cultivation following the planting of contour rows, the mixing of subsoil with topsoil and fertilizer elements in the form of artificial applications or turned-under cover crops, the resulting soil is invariably very desirable for tree root and top growth as well as for moisture infiltration and conservation. The so-called Reddick (California) bench terrace is constructed in this manner covering a period of about 10 years. Starting with the tree rows on little more than plow back-furrows, such terraces will be 6 feet above each other on some slopes by the end of the 10-year period when they usually reach a more or less permanent profile and size. The steep down-slopes or "risers" of such terraces are usually maintained in permanent vegetation.

Depending upon their size and span of construction, orchard terraces may be built with implements ranging from a disk harrow or plow to a 10-foot blade terracer. When a plow is used, the channel is often enlarged by following with a V-drag; this is also desirable to throw the loose soil nearer the tree row where the ridge will be less apt to be broken down by other orchard machinery. Terraces may be constructed from both sides as in the case of the Mangum or broad-base type, or

from the upper side only as with the Nichols terrace common in the Southeast.

More than one type of system has also been used in the contour planting and terracing of orchards or vineyards. For instance, a terrace may exist for each and every tree row, which at the beginning or in time, depending on its size, will catch all run-off from the row middle above it. This is invariably the case in a system of bench and level terraces which are usually all of the



Typical contour planted orange grove in Southern California. This is the ranch of "Ramona" in Helen Hunt Jackson's book of that name.

same size whether constructed prior to planting the orchard or allowed to develop over a period of years. In contrast to that, we find the use of so-called "master terraces," usually of the diversion type, which may be spaced at every second, third, or even fourth tree row, with the intervening rows, a portion of which may be point or spur rows, on the contour. In such an instance, however, these rows become "terraced" as a result of contour cultivation so that they hold all rainfall except in the heaviest rains when the excess run-off is caught by the diversion terrace below.

Another variation in planting systems has to do with the lining up of rows in the opposite direction from those on the contour. These have been "staggered" in some plantings by merely planting at given tree intervals. In other orchards, however, the trees are kept in line up and down the slope to permit on gentle slopes an occasional cultivation to remove weeds or vegetative cover in the contour tree rows, or more commonly, for the sake of appearance. Better air drainage has also been advanced as a desirable feature of this method. Sometimes the contour rows change direction to the extent that it is impossible to line up in parallel all the rows in the other direction, in which case a radial system is employed. From the standpoint of planting distances, it is often recommended that the contour rows be spaced somewhat wider than in the square-planted orchard, but that the trees in the contour rows be placed correspondingly closer together.

Although contour orchard planting in conjunction

with proper terracing ordinarily provides adequate erosion control, it is sound orchard practice to employ certain other practices in the orchard designed for soil building and fruit production. In this connection cover crops and mulching should be considered. When an orchard is newly planted, even the contour rows may not have ridges or terraces of sufficient capacity to check run-off fully. Here, a vegetative cover which might be the previous hay crop can be left in the contour tree-row middles as buffer strips; or if not already there, one can be planted. If the orchard is interplanted with a row crop such as strawberries or corn, the contour cultivation received by the intercrop will provide increased water storage, though these crops are not as desirable as a close-growing intercrop such as alfalfa. As the trees become larger and the root systems spread into the row middles, the cultivation which is gradually increasing the capacity of the terrace channel in each row also breaks up, year by year, a little of the inter-row cover crop, the final result being completely cultivated middles. When this stage is reached, a good annual cover-crop system will aid materially in preventing soil movement into the terrace channels, as well as in maintaining a porous soil to promote water absorption. In older orchards where shading interferes with a good cover-crop growth, mulching has proved a desirable substitute for orchard cover crops. Mulching of the terrace ridges has also been done to hold down weed growth and to aid in keeping ridges well stabilized at a desirable height to maintain sufficient channel capacity.

Although experimental data are yet rather limited regarding the more fundamental effects of contour cultivation and terraces on fruit plants and the soil, certain observations have been made which should be of interest. On the favorable side of the picture it has been definitely shown that soil and water conservation has been accomplished by terracing. It has also been noted that young trees in practically all locations make a superior growth when planted on terraces which are built largely of topsoil.

When an enlargement of the terrace takes place during a period of several years, the addition of a considerable layer of soil over the original tree roots has not proved harmful to the trees. Evidently the roots grow into this new soil layer and probably have an even greater feeding area than formerly. The terracing of existing orchards, where gulying was about to result in abandonment, has brought about an immediate stabilization of the orchard site, and has also materially prolonged the productive life of the trees. The economy of contour orchard operations might be mentioned as an additional advantage.



Terraces produced by contour cultivation when the orchard was young.

On the other hand, a few less desirable features in connection with contour planting have been observed here and there which should be mentioned. In some cases, these are the reactions of fruit growers who are utilizing this practice for the first time and who naturally find certain inconveniences they have not yet learned to cope with. One-way cultivation in itself is unpleasant to many fruit growers who have been taught that weeds or other vegetation left in the orchard during the cultivation period is nothing short of a disgrace. There is also the problem of spur rows, those short or point rows which, since they do not run the entire distance of the orchard, are particularly unhandy from the standpoint of spraying. A stationary spray system would solve this problem. Also in relation to spraying or dusting with the wind, there is the problem of a change in row direction when contour planting is done on certain sites. As a rule, however, most of the foregoing objections can be met by pointing out the lesser of two evils, and the practice which really saves the orchard or vineyard usually wins out.

Because of the far-reaching importance of the orchard and vineyard erosion problem and the widespread application of contour planting and terracing in meeting this problem, there is a real demand for some fundamental research along this line. For one thing, the moisture relationships of terraces of different sizes and profiles should be studied from the standpoint of where the trees should be planted, whether a cover crop will offer less competition under these conditions, etc. There may also be differences in fertilizer requirements, where all that is put on is conserved for the

use of the trees. There should be some definite data on the effectiveness of contour planting and terracing in increasing fruit production (i. e., yields). Another problem for study is the effect of noncultivated terrace ridges or down slopes—whether in permanent vegetation or mulched—on the curculio and rodent problem.

Studies touching some of these problems are already underway. At the Hammondsport, N. Y., Soil and Water Conservation Experiment Station, a new contour- and bench-terraced vineyard has been planted on a steep slope where the soil moisture is being studied under mulched and unmulched ridges. In addition there are adjoining blocks of bearing vineyard, one planted and cultivated on the contour while the other is planted and cultivated up and down the slope, from which water run-off, soil loss, and production records have been taken for 3 years. A summary of these data, which show a decided advantage in favor of the contour block, is given in the accompanying table.

Effect of contour cultivation in New York vineyard, planted in 1910. Elvira variety, slope 25 percent. The plots were 225 feet by 48 feet. Yields, water and soil losses are computed on an acre basis ¹

Year	May to October rain-fall	Up-and-down cultivation			Contour cultivation		
		Yield	H ₂ O loss	Soil loss	Yield	H ₂ O loss	Soil loss
	Inches	Pounds	Inch	Pounds	Pounds	Inch	Pounds
1935.....	27.2	5,748	.....	.....	5,944	.....	.....
1936.....	12.4	1,044	0.211	3,093	2,124	0.029	72
1937.....	16.4	5,372	.054	176	7,876	.011	10
1938.....	10.0	2,256	.....	.....	3,464	.....	.....

¹ Preliminary Report, 1938. By Dr. John R. Lamb, Jr., project supervisor, Soil Conservation Experiment Station, Ithaca, N. Y.

(Continued on p. 263)

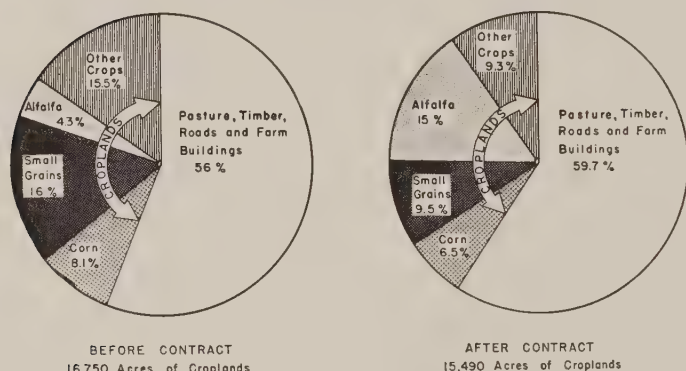
Coon Valley—4 Years After

By R. H. Musser¹

IT WAS in the fall of 1933 that the Soil Conservation Service—then known as the Soil Erosion Service—began operations on this 92,000-acre watershed. At that time, Coon Valley was known as one of the most severely eroded agricultural areas in the Upper Mississippi region. Located in the heart of the unglaciated or so-called “Driftless Area” of southwestern Wisconsin and southeastern Minnesota—an area characterized by steeply sloping land and a highly erodible soil—Coon Valley showed the marks of years of exploitation. By cutting down much of the timber, permitting cattle to graze in the rest of it, and cultivating sloping fields

EROSION CONTROL PROGRAM CHANGES LAND USE ON COON VALLEY, WISCONSIN, FARMS

Survey of 374 Farms included in Soil Conservation Service Erosion Control Agreements affecting 38,303 acres of Land



in straight up-and-down hill rows, the white man had speeded up erosion processes tremendously. In many places huge gullies cut back through valuable cropland, and small shoestring gullies were to be found after a heavy rain in nearly every sloping field. Sheet erosion was everywhere evident.

Working in cooperation with the Wisconsin Experiment Station, the Extension Service, and individual farmers in the area, Soil Conservation Service officials began at once to set up a program of erosion-control demonstrations. On the land of farmers who had signed cooperative agreements with the Service, control programs including terracing, strip cropping, gully control by trees and dams, and woodland protection against grazing were established. Contour or around-the-hill farming replaced straight-row farming on the sloping land. Shifts in land use were made to give the maximum amount of protection to steep land: hay crops replaced clean-tilled crops on severe slopes, and such crops as corn were confined to the more nearly level land.

¹ Regional conservator, Soil Conservation Service, Milwaukee, Wis.

COON VALLEY PROJECT IN



BLACK AREAS INDICATE FARMS ON WHICH EROSION CONTROL PROGRAMS HAVE BEEN ESTABLISHED

Today, it is clearly evident that the battle against the erosion menace is being won on the demonstration farms. Literally thousands of small shoestring gullies have been plowed in and completely healed as a result of terracing, contour strip cropping, and the other phases of the program. Dams and trees have effectively controlled larger gullies. Farmers in the area will tell you that erosion losses on controlled land are today but a fraction as great as they formerly were.

From the standpoint of farm management, the shift in land use has been the outstanding change brought about by the conservation program. A recent survey revealed that on 374 farms included in the demonstration program, the total acreage of cultivated land has been reduced from 16,750 to 15,490 acres, a reduction of 7.5 percent.

In the 1934 crop season, before the program had had a chance to go into effect, the 374 farmers raised 3,090 acres of corn. Last year they raised a little over 2,500 acres. In other words, they have reduced their corn acreage by approximately one-fifth. With regard to small grain, the acreage reduction has been even more drastic. In 1934, the cooperating farmers raised nearly 6,100 acres of grain. In 1937, they raised only 3,650. The acreage in small grain has been cut almost in half.

On the other hand, the acreage in hay crops has been considerably increased. With regard to alfalfa, the increase is especially striking. In 1934, a little over 1,640 acres of alfalfa were grown on cooperators' farms. In 1937, those same farms raised more than



Coon Valley farmers have fitted their field practices to the lay of the land. Curved farming is practiced in this curved country—to conserve soil and water. Contour strip cropping is common in the area.

5,780 acres of alfalfa. As a result of the erosion-control work, the alfalfa acreage has been increased over three and one-half times.

At first thought it might seem that, from the short-time point of view, farmers could not afford to reduce the acreages in cash crops as drastically as the Coon Valley farmers have done. Granted that the shift in crops was necessary for effective control of erosion, must it not, nevertheless, make a deep dent in the farm income?

The answer, as supplied by the farmers themselves, is that, far from working a hardship, the shift from cash crops to hay has been a lifesaver during the recent drought years. Alfalfa from Coon Valley was shipped out to farmers all over southwestern Wisconsin the year before last.

Coon Valley is in the heart of the dairy region, and in 1936 the farmers derived 66 percent of their income from dairying; hence, crop returns can be figured quite accurately in terms of nutrient production, and it is apparent that the erosion-control program has resulted in an actual increase in the amount of feed produced on the farms. The reduction made in corn and grain has been more than offset by the increase in alfalfa. The production of nutrients in the form of grain has been cut nearly in half; but in the form of roughage, nutrient production has been increased by more than 50 percent. In the beginning, the production of roughage was so much greater than the production of grain that the end result is a marked increase in total feed.

Approximately 23 million pounds of total digestible nutrients were produced on the farms each year before the erosion-control work was started. Last year, 28,157,000 pounds were produced, an increase of more than 5,150,000 pounds; however, the number of livestock on the farms has shown no corresponding increase. During the first 2 years of the program, there was only a 0.9-percent increase in the number of milk cows and only a 4.4-percent increase in young stock.

The butterfat production per cow, however, is on the increase on the 374 farms. In 1934, the average annual butterfat production was 166 pounds per cow. In 1935, the average was 190 pounds per cow. In 1936, the average was 207. In other words, the average production per cow has been increased by 41 pounds during the period between 1934 and 1936.

It seems safe to attribute this increase directly to the shift in crop acreage with its consequent increase in nutrient production and improvement in the quality of feed. Farm management specialists point out that a cow producing 208 pounds of butterfat a year requires 3,500 pounds of total digestible nutrients in addition to 168 pasture days. In Coon Valley, farms included in erosion-control agreements are much more likely to fill these requirements than farms operated in the usual way.

In the Northwest a 4,000-acre Oregon ranch profits to the extent of \$1,200 for hunting privileges sold to a group of 20 sportsmen.

Kudzu Plants by the Million

This valuable erosion-control plant is pictured on the front and back covers of this issue

FIELD operations in Region 2 have produced proof without end of the value of kudzu vines for erosion control, soil building, and forage production. This perennial legume, introduced from Japan, grows vigorously under favorable conditions; it roots at the nodes and produces a network that ties down steep gully banks, badly eroded fields, terrace outlet channels, and roadside banks and ditches. Kudzu hay is highly palatable and nutritious.

To supply plants for demonstration projects, camp work areas and soil conservation districts, the nurseries in Region 2 planted 3,926 pounds of seed in the spring of 1938. Early in the fall, definite plans were made for allotting, obligating, distributing and planting 12,000,000 seedlings—enough for 24,000 acres. The regional nursery report for February 1939 shows that 13,658,500 plants have been dug, an average of 3,479 plants per pound of seed.

The following extract from a joint report by J. N.

Lowe, assistant regional agronomist, and John M. Downing, assistant regional engineer, shows how well the kudzu planting program has progressed in the northern half of Mississippi.

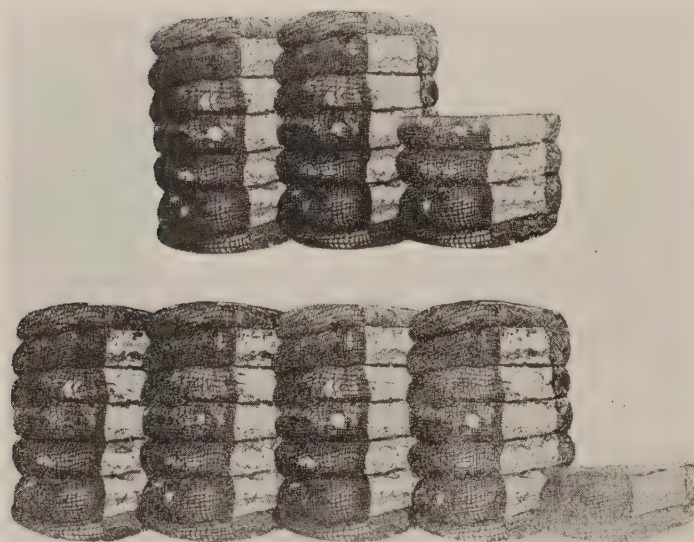
SUMMARY OF THE KUDZU PLANTING PROGRAM AS OF FEB. 16, 1939

Camp or project	Plants allotted to project	Obligated to cooperation	Received	Planted	Percent of land prepared
					Percent
New Albany.....	200,000	173,000	80,000	40,000	90
Coffeeville.....	200,000	179,400	99,500	74,500	75
Oxford.....	325,000	292,623	120,000	40,000	85
Senatobia.....	350,000	351,000	110,000	80,000	80
Ecu.....	250,000	219,670	74,000	74,000	90
Ashland.....	300,000	262,000	124,500	120,000	75
Lexington.....	300,000	293,494	174,604	115,493	85
Total.....	1,925,000	1,771,187	782,604	543,993	83

The Lexington, Senatobia, and Ashland camps have reported that they can use more plants if they are available.

Closed Level Terraces—No Run-off in 12 Years

By R. E. Dickson, B. C. Langley, and C. E. Fisher¹



Total production of cotton per acre in 12 years (1927 to 1938): Upper, from land having rows with slope; lower, from land having closed level terraces.

TWELVE years ago, July 1926, a conference was held at Spur to develop plans for extending the soil and water conservation studies begun at the Texas Agricultural Experiment Station earlier in the year.

¹ Superintendent, agronomist, and assistant soil conservationist, respectively, of the Texas Agricultural Experiment Station, Spur, Tex. Since June 1936 these studies have been conducted cooperatively with the Soil Conservation Service.

In attendance were county and district agents of the region, representatives of the school of agriculture, the extension service and the experiment station of the A. & M. College of Texas, and H. H. Bennett, then of the Bureau of Chemistry and Soils, United States Department of Agriculture. Level terraces constructed on the station lands during the previous winter already had indicated that they were to be preferred over terraces with a slope. A suggestion from one of the group to close the ends of level terraces met with considerable good natured ridicule but it was finally agreed that it should be tried out as a purely experimental venture. The conference members decided on the location of the 20-acre experimental area, a piece of land mapped as Abilene clay loam with a slope of one-half of 1 percent. This much fall had frequently been given terraces in western Texas, and the prevailing opinion was that land so nearly level did not require terracing.

The area was divided into two experimental blocks. On one, closed level terraces with an effective height of 18 inches were constructed with vertical intervals of 12 inches between terraces. The other block was not terraced and the rows were run with the slope.

These two blocks of land have been planted continuously to cotton during the 12-year period, 1927 to 1938.

No run-off has occurred from the area having closed level terraces and none of the crops have been damaged by too much rain. During this period a number of rains have been highly torrential and, also, the largest monthly rainfall in the history of the station, 11.13 inches, was recorded in September 1936.

The run-off from the unterraced area was determined with an Au-Fuzee water stage recorder operating over a stilling well adjacent to a stilling pond with a double V-notch weir at the lower end. It is generally conceded that this device gives highly accurate run-off measurements. The run-off results obtained over the 12-year period are presented in the accompanying table.

Run-off, yields, and market values of cotton from terraced and unterraced areas

Year	Rain-fall	Run-off from land not terraced		Yield, lint per acre			Price per pound	Increased acre return
				From land not terraced	From land with closed level terraces	Increase		
	Inches	Inches	Percent	Pounds	Pounds	Pounds	Cents	
1927.....	16.12	0.38	2.36	239	279	40	22.75	\$9.10
1928.....	19.99	2.88	14.41	58	217	159	16.63	26.44
1929.....	14.76	2.52	17.07	0	0	0	.....	0
1930.....	18.60	1.49	8.91	9	104	95	8.20	7.79
1931.....	16.46	.36	2.19	186	229	43	5.61	2.41
1932.....	27.70	2.83	10.22	0	0	0	.....	0
1933.....	15.59	.90	5.77	325	441	116	10.91	12.65
1934.....	12.88	.79	6.13	0	0	0	.....	0
1935.....	23.78	3.06	12.87	118	270	152	11.18	16.99
1936.....	24.37	3.98	16.33	39	55	16	8.39	1.34
1937.....	20.28	4.16	20.51	186	292	106	6.62	7.02
1938.....	19.24	3.24	16.84	147	236	89	8.42	7.49
Total.....	229.77	26.59	.....	1,307	2,123	816	.....	91.23
Average.	19.15	2.22	11.57	109	177	68	10.97	7.60

The cotton crops in 1929 and 1932 were destroyed by hail, and a complete crop failure occurred in 1934, the second of two very dry years. During the years when crops were harvested, material increases in yields were obtained where all of the water was held, and in 1928, 1930, and 1935 the yields were more than doubled. The total increased yield for the 12-year period was 816 pounds of lint and 1,306 pounds of seed per acre. At an average price of 11.18 cents per pound for lint, and an estimated value of \$20 a ton for seed, the increased value was \$104.29. The increased cost of harvesting the larger crop, at 50 cents per hundredweight for snapping, was \$16.12, and that of ginning at 30 cents per hundredweight was \$9.79, or a total of \$26.11. This leaves a balance of \$78.18 an acre, which is the net return from holding all of the water on the land for a period of 12 years.

The average annual return is \$6.51 an acre, and this agrees with reports made by individuals using similar water conservation practices in this region.

Information is not available as to the amount of soil lost by erosion from the unterraced area, but experiments conducted under similar crop and slope conditions at this station show that with each inch of run-off 1.93 tons of soil are eroded. At this rate the soil lost from the unterraced area was 51.42 tons per acre during the 12-year period.

The practice of using all of the rainfall in cotton production gave such marked increase in yields that a further step in water utilization was undertaken in 1931. Flood water from 1,200 acres of rough land was diverted on to 120 acres of comparatively level land over which it was spread by means of level terraces with alternate ends partly open. This system of terraces is referred to as the "sirup-pan" system. The amount of water made available for crop production over a period of 8 years has been increased 19.5 percent above the natural rainfall. Cotton, comparatively sluggish in the use of water, has not been able to use this additional water as advantageously as some of the sorghum feed crops which have the ability to utilize large amounts.

This experiment has special value in that the results have been consistent over a relatively long period of years. During the 12-year period a number of torrential rains have occurred and also protracted rain periods of heavy rainfall without the loss, or even damage, of crops from excess moisture. It points definitely to the use of practices that will utilize the soil as a store place for water.

CONSERVATION IN ORCHARDS

(Continued from p. 259)

Another study relating to the moisture content at various locations in the terrace is being initiated by the Service in cooperation with the Pennsylvania State Experiment Station in southern Pennsylvania. Evaluation surveys on Soil Conservation Service operation projects in various parts of the country have also been set up to determine, as far as possible, effective size and interval of orchard terraces under various soil types and auxiliary erosion-control practices, and to evaluate several satisfactory and economical methods of building terraces in the orchard where the fruit grower is using ordinary farm or orchard machinery.

At Falcon, Colo., a rancher receives \$120 a year for duck-shooting privileges and \$75 a year for his half-share of the muskrats taken by a local trapper from four lakes on 640 acres.

Puerto Ricans Serve Conservation Program

WHEN, some two and a half years ago, Soil Conservation Service technicians began the development of a program in Puerto Rico, they found themselves faced with problems extraordinary. They must control erosion in a small mountainous country and at the same time tolerate and help to maintain a "slope agriculture" to provide subsistence for a dense population. Sugar centrals covered the rich valleys and the narrow coastal plains; food crops must be raised largely on the sides of steep mountains or in the foothills. Many of these slopes were badly eroded, and because of the dense population, and the surrounding ocean, a land-retirement program was out of the question. Erosion must be controlled inexpensively and the revegetative plants used must be principally food plants.

In the beginning it seemed that not the least of the problems was that having to do with the training of native Puerto Ricans to serve as agricultural agents and aides in setting up soil and water conservation practices. But G. L. Crawford, in charge of the work of the Service on the island, discovered, while preliminary research and operations were in progress, that students of the College of Agriculture of the University of Puerto Rico were interested in saving the soil of their mountainous tropical country and eager to learn the approved methods of the Federal Soil Conservation Service. Some of these men were already working with the farm program of the Puerto Rican Reconstruction Administration, and they were quick to see the need for soil conservation methods in their vocational agricultural program. The Reconstruction Administration then made it possible, by furnishing the necessary funds, for these technicians and

students to work with members of the Service staff in surveys, research, and demonstrations. These native technicians, paid from funds supplied by the Reconstruction Administration, are now working on soil and water conservation problems in cooperation with the Service, and they are attacking the various phases of the program with extraordinary enthusiasm for the details of the practices adaptable to the island.

Some months ago, to encourage these native Puerto Rican agents and aides, Mr. Crawford arranged a competition for articles written by them, in English, on any soil conservation subject. Nineteen articles were prepared and sent to Washington to be read and judged by the officials concerned. The judging was difficult, as all the papers were well done. First place went to Joaquín Oliver, for his article on the soil erosion control work at La Plata Farm in the Cayey area. He presents an excellent and detailed picture of soil conservation demonstrations in an old tobacco region of the tropical country. Ovidio Garcia Molinari's observations on Possible Erosion Control Grasses of Puerto Rico was judged second-best of the 19 articles. He gives a careful account of the methods of study and the grasses investigated at the Soil Conservation Service research plots at Rio Piedras. Third place was won by Samuel Gracia, soil surveyor, for his paper, Soils, Soil Conditions, and Their Relation to Erosion Control Practices in the Cayey Area.

These three articles are presented in part on the following pages. They tell, better than could be told in any other way, the story of the work of the Soil Conservation Service during recent years in Puerto Rico.—PHOEBE O'NEALL FARIS.



General view of Soil Conservation Service practices over La Plata Valley and La Plata Hill, Cayey area, Puerto Rico.

I

Soil Erosion and its Control at La Plata, Cayey Area

By Joaquín Oliver

LA PLATA farm was first cleared about 1889. The first to plant tobacco in this section were the Rucabados and they continued the practice for 13 years. The Puerto Rican Reconstruction Administration bought the farm in 1935.

It consists of 721.15 cuerdas [0.97 acre] and is divided as follows: Central service farm 39.99 cuerdas; vocational school, 74.9821; tobacco institute, 10.5347; Insular rural school, 1.0385; roads, 8.6110; brooks, 0.8040; under cultivation, 172.87; idle land and pasture, 449.9593 cuerdas.

The Puerto Rican Reconstruction Administration has maintained the Central Service Farm and the rest of the cultivated land was divided into parcels and distributed to laborers, each parcel with concrete house and 5 to 9 cuerdas of land. The parcel owners

pay a small rent for their house and land and it is supposed that in the near future they will pay for them under a 20-year payment plan; at the end of the 20 years they will have fulfilled their contracts and the parcels are automatically their own.

Rural life at La Plata has improved a great deal. Before 1898 workers earned about 37½ cents daily, and later the corporations paid their workers 50 to 60 cents a day. From 1935 on, their wages have increased to \$1.50 a day. A farmer lives a better life with a good house and a piece of land on which to make his living.

The normal rainfall is about 55 inches, most of which falls in highly intensive rains from June to November. The rest of the year is almost dry. Topographically, La Plata Farm is a valley bounded

by mountains with undulating slopes with gradients from 25 to 75 percent.

Extending from the hills are colluvial slopes having less grade but the land is always more or less rolling with intermittent streams leading to the Rio Grande de La Plata which flows throughout the year * * *.

For many years this land has been subject to abuse and misuse. Improper cultural practices in tillage and cultivation have caused the loss of topsoil from large areas and a severe loss of other natural resources as well. There too has been a wastage of fertility by overcropping as a consequence of pioneer period of development and exploitation. Much of the best cropland is already seriously damaged. It was found that the limiting factor in the Cayey area was the lack of technical knowledge and that a sound soil conservation program would have to be established so that farmers chiefly dependent on crop production for their subsistence might learn conservation methods of crop production and soil fertility maintenance.

The Soil Conservation Service at La Plata has provided the necessary means and equipment to put into practice several demonstrations. The purpose was to control old practices that were leading to increased erosion and to establish modern and scientific soil-conserving and soil-building practices.

The work at La Plata began with a general survey of all parcels to collect local information regarding cultivation practices, kind of crops grown, etc. This was followed by an erosion and soil survey to determine the special needs of the individual farms and areas.

Demonstrations on strip cropping, barrier strips, terracing, vegetative protection of outlet channels and ditches, hillside or diversion furrows, and crop rotation are now carried on in this section of the Cayey area. The objective is to discover which are the best practices to be recommended to farmers so that they can make better use of their land.

On those lands which have been in cultivation and where erosion is rather serious, strip cropping is on trial. Bands of close-growing crops are put on the contour, alternated with the regular row crops. The width of the strip is determined by the slope of the land and type of soil. The principle involved is that the bands or strips shorten the slope, reducing the speed of the running water and acting as a filter to the soil being carried out by the running water; also the strips serve as water spreaders and prevent the concentration of water in low places.

To observe what is the best to recommend, Soil Conservation is trying the following: (1) Strip cropping on the contour; (2) strip cropping with furrows

of 0.8-foot fall per 100 feet at lower side of cultivated strip; (3) strip cropping with a cane-like grass planted on the upper part of the cultivated strips.

The importance of contour tillage in combination with strip cropping, as well as proper crop rotation in them, is specially emphasized and put into practice.

The possibility of forming a bench terrace with subsequent plowings to a cane-like barrier plant is another of the practices on trial at La Plata. To test their effectiveness for erosion control, several kinds of barrier strips are being demonstrated. Among them are:

(1) Barrier strips planted on a ridge resulting from the construction of a furrow of 0.8-foot fall per 100 feet;

(2) Barrier strips with a furrow of 0.8-foot fall per 100 feet, beneath the barrier plants;

(3) Barrier strips consisting of a 3-foot row of natural grass; and

(4) Barrier strips with barriers planted on the level (without a furrow).

The abilities of different barrier plants to withstand plowed dirt, as well as their stooling qualities, soil adaptations, and drought resistance, are also on trial. The plants being tested are milo maíz, dwarf milo maíz, white kafir, Sudan grass, Merker grass, Guatemala grass, elephant grass, pigeon peas, *Crotalaria*, and sweetclover.

Barrier strips are staked on moderate slopes which have sufficient soil for the formation of a bench terrace; and vertical spacings of 4 and 6 feet are being tried out.

On the Mabí soils where there is deep and approximately uniform level soil, and where the slope does not exceed 15 percent, terracing is the soil conservation practice used. These are no more than ridges of earth thrown up across the hillside, but in making the ridge a broad shallow channel is formed along its upper side through which the collected water flows at a very low velocity to the outlet channels.

The entire field can be cultivated by the farmers. For planting tobacco in this region Soil Conservation Service has suggested running the rows with a 2-percent grade between the terraces; for other crops the rows are run parallel to the terrace. The vertical distance or drop between terraces depends on the slope of this land and soil type.

Old natural water courses are reshaped and used as terrace outlet ditches. Bermuda sod strips are placed at 6 inches vertical spacing. The rapid growth of Bermuda grass and the manner in which the interlocking rootstocks and runners cover the whole sur-

face of the channels serve to prevent soil erosion and gully formation within them. Horquetilla grass is being tried in some of the ditches; it is very similar to Bermuda grass in stooling qualities.

As a substitute for the old diamond ditches on the tobacco lands, hillside or diversion furrows are being constructed. The different vertical spacings used are 6, 12, and 18 feet, with a fall of 0.8, 1, 1.5 feet per hundred feet, respectively. Diversion furrows with 6-foot vertical interval are 8 inches wide and 6 inches in height; those staked at 12 feet vertical interval are 10 inches wide and 8 inches in height, and those at 18

feet are 12 inches wide and 10 inches in height. All of them have a side slope of 1:1 and are not longer than 500 feet.

One of the objectives of the Soil Conservation Service in the work at La Plata is to give farmers an understanding of the value of crop rotation in maintaining soil productivity and soil improvement and to reduce erosion. A cropping program covering a period of 5 years is being worked for all parcels. Adaptations of crop to soils and the favorable sequence in maintaining fertility and physical conditions of the land are being closely observed.



Stabilizing a big gully at Rio Piedras.

II

Observations on Possible Erosion Control Grasses of Puerto Rico

By Ovidio Garcia Molinari

FROM all over the island different species of grasses have been collected and planted in small plots (one one-hundredth of an acre each) and placed under observation at the Soil Conservation Service research station at Rio Piedras. All those showing possibilities for use in any phase of soil and moisture conservation have been transferred to concentration plots to determine their values for use in protecting terrace outlet channels and terrace banks, for barriers, for controlling head erosion in gullies, for gully slope stabilization, for road banks, levees, and ditches, for controlling sheet erosion, and for pasture revegetation.

During the observation period, all possible data are being obtained relative to the characteristics and methods of handling the grass, as well as its adaptability to particular environments and uses. Notes are also taken on all species of grasses under observation regarding the following: Longevity; height; habitat; habit of growth; propagation; resistance to diseases, insects, droughts, excessive moisture; root system; clump or sod forming characteristics; growth rate; soil and moisture conservation properties, including soil-binding capacity, moisture-conserving and humus-forming properties, soil protective cover,

adaptation to a wide range of soil and climatic conditions, procumbent growth habit for prevention of sand blowing as well as sheet erosion. The grasses are studied also from the standpoint of their economic values—for forage, for industrial uses, or for sundry uses such as lattices and farm constructions or ornamental purposes.

All available facts are obtained regarding common farm practices, such as proper rate and depth of seeding, time of planting, methods of planting, blooming time, time elapsed between blossoming and shattering of mature seeds, after-ripening period, and cultural practices necessary for ultimate, successful establishment in demonstration projects and on farm lands.

The recommendations suggested in this paper regarding the use of some of the most promising native grasses for erosion control, are based on personal observations during 5 months of work in the Soil Conservation Service. After further experimentation has been done some of these suggestions and conclusions will undoubtedly be modified.

Grasses Suitable for Terrace Outlet Channels

The best grasses for use in outlet channels are those short-growing grasses, not over 12 inches in height, preferably only 4 to 6 inches tall, with fine stems and leaves that will be easily bent by the flowing water, with a dense, close-growing type of growth covering the entire surface of the ground.

Some of the grasses growing wild in Puerto Rico, and which show possibilities for terrace outlet protection are the following:

Bermuda grass, *Cynodon dactylon* (L.), Pers.—This is an excellent grass for outlet channel protection. It has a dense type of growth, short, fine stems and leaves easily bent by the flowing water, and widely creeping stolons producing roots at the nodes. It forms a thick mat not over 8 inches high and covers the entire surface of the ground. Its netted root system, several inches deep, extends in every direction. It can be successfully propagated either by seeding or vegetatively. It is a perennial, highly resistant to droughts, diseases, poor soil conditions, and hurricanes and is adapted to soil types having different physical and chemical conditions. Its great rapidity of establishment and its aggressiveness are important characteristics.

One point against this grass is its rootstock-forming habit which makes eradication from cultivated fields very difficult. It is not as desirable as many other grasses, due to its low palatability. It is, nevertheless, relished by livestock when they get accustomed to it, specially horses, mules, goats, rabbits, and chickens.

Centipede grass, *Eremochloa ophiuroides* (Munro), Hack.—This grass has been recently introduced from the United States. It is a creeping, stoloniferous grass, not over 5 inches tall, thus making an excellent cover for outlet channels. It forms a thick mat above the ground, and has a netted root system extending 6 to 8 inches vertically into the ground as well as laterally. It develops runners or stolons frequently, with more than 20 roots per linear foot of stolon. Its soil-binding ability is excellent. In general, it is as good for soil erosion control as Bermuda, having the advantage over the latter in that it does not produce rootstocks and therefore is not so difficult to eradicate.

One disadvantage of the Centipede is that the percentage of seed germination is relatively low so that it has to be propagated vegetatively and during a favorable rainy season.

Knotgrass, *Paspalum distichum*, L.—This grass is now being tried for use in erosion control in Puerto Rico. According to observations thus far, it appears to be well adapted for use in outlet channel protection as well as for ditches, terrace banks, and gully bank stabilization.

Its resistance to prolonged droughts, its adaptability to poor soil conditions as well as its ability to thrive in wet soils cannot be surpassed by many other short-growing grasses. It grows as rapidly as, if not more rapidly than the Centipede or Bermuda grass. It is a widely creeping grass, very stoloniferous with growth above the ground of 4 to 12 inches forming a mat-like coverage. It can be propagated vegetatively as well as by seeds. It does not produce rootstocks and is relished by livestock. It can be planted at any season of the year.

Java grass, *Polytrias amaura*.—This grass is not as stoloniferous as the Centipede, Bermuda, or *Paspalum distichum*. It forms a very thick covering on the surface. It is a short grass, not over 6 inches tall, with very fine leaves and stems that can be easily bent by flowing water.

This grass undoubtedly has possibilities for use in ditches and outlet channels as well as for diversion channels and terrace banks.

A point against it is that it seems to be attacked by the chinch bug, *Blissus leucopterus*, in the western part of the island, although in the northern and eastern parts it does not show any injury from this insect.

Grasses Suitable for Barriers

Several species of grasses have been tested for barrier use in Puerto Rico. Those listed below have been under observation for some time and because they are

long-lived (perennial), have deep, penetrating, extensive root systems and comparatively thick, erect stems, strong stooling habits, and are useful for forage or for industrial purposes, it is thought that they will respond to barrier requirements.

Elephant grass, *Pennisetum purpureum*, Schum.
Guatemala grass, *Tripsacum laxum*, Nash.
Merker grass, *Pennisetum purpureum* var. Merkeri.
Japanese cane, *Saccharum officinarum*, L.
Wild cane, *Gynerium sagittatum* (Aubl.), Beauv.
Indian cane, *Phragmites communis*, Trin.
Equatorial grass, *Pennisetum occidentale*.
Jobs-tears, *Coix lacryma-jobi*, L.

Grasses Suitable for Terrace Banks

Grasses for this use should be perennials producing extensive netted root systems and having decumbent growth and an abundance of roots coming from nodes (stoloniferous). Their growth should be rapid and they should form a thick covering of the entire bank surface. In addition, they should have value as forage or pasture.

Such native grasses in Puerto Rico are the following:

Sour grama, *Paspalum conjugatum*, Bergius.
Centipede grass, *Eremochloa ophiuroides* (Munro), Hack.
Knotgrass, *Paspalum distichum*, L.
St. Augustine, *Stenotaphrum secundatum* (Walt.), Kuntze.
Carpet grass, *Axonopus compressus* (Swartz), Beauv.
Bermuda grass, *Cynodon dactylon* (L.), Pers.
Java grass, *Polytrias amaura*.
Malojilla, *Eriochloa polystachya*, H. B. K.
Molasses, *Melinis minutiflora*, Beauv.
Straw grass, *Andropogon annulatus*, Forsk.

Grasses Suitable for Controlling Erosion at the Heads of Gullies

Grasses for this purpose should possess, among others, the following characteristics: (1) A deep extensively netted root system; (2) stout stems (culms) with sufficient strength to support great forces; (3) strong stooling habits; (4) long-life (perennial); and (5) abundance of above-ground growth or foliage. Some of the most outstanding native grasses in Puerto Rico for such a purpose are:

Bamboo, *Bambusa bulgaris*, Schrad.
Pito, *Lasiacis divaricata* (L.), Hitchc.
Wild cane, *Gynerium sagittatum* (Aubl.), Beauv.
Caña India, *Arundo donax*, L.
Common reed, *Phragmites communis*, Trin.
Pachuli, *Vetiveria zizanioides* (L.), Nash.
Matojo blanco, *Paspalum virgatum*, L.
Gramalote, *Panicum maximum* Var., X.
Uba cane, *Saccharum officinarum*, L.
Guatemala, *Tripsacum laxum*, Nash.
Rattail, *Arundinella confinis* (Schult), Hitch. and Chase.
Sweetgrass, *Paspalum plicatulum*, Michx.

The following creeping stoloniferous grasses are to be used in combination with those mentioned above:

Molasses grass, *Melinis minutiflora*, Beauv.
Carpet grass, *Axonopus compressus* (Swartz), Beauv.
Knotgrass, *Paspalum distichum*, L.

Malojillo del monte, *Panicum laxum*, Swartz.
Carruzo, *Ichnanthus pallens* (Swartz), Munro.
Yerba de Madera, *Oplismenus hirtellus* (L.), Beauv.
Sour grama, *Paspalum conjugatum*, Bergius.
Pendejuelo, *Paspalum decumbens*, Swartz.
Straw grass, *Andropogon annulatus*, Forsk.
Palmilla, *Setaria palmifolia* (Willd.), Stapf.

Grasses Suitable for Use in Controlling Erosion on Gully Embankments

These grasses should possess a deep extensive root system, and should be preferably stoloniferous. They should form a thick growth above the ground capable of covering the entire surface of the bank and forming a layer of humus (decayed foliage), that will add to the organic content of the surface soil, and at the same time prevent the direct beating of raindrops against the bare soil and subsequent mud formation and soil washing. The grasses must have some economical value, either as forage or for industrial uses. Such grasses in Puerto Rico that are adapted for gully bank stabilization are:

Molasses, *Melinis minutiflora*, Beauv.
Melojilla, *Eriochloa polystachya*, H. B. K.
Knotgrass, *Paspalum distichum*, L.
Centipede, *Eremochloa ophiuroides* (Munro), Hack.
River grass, *Echinochloa polystachya* (H. B. K.), Hitchc.
Trompetilla, *Hymenachne amplexicaulis* (Rudge), Nees.
Aquatic grass, *Panicum aquaticum*, Poir.
Para grass, *Panicum purpurascens*, Raddi.
St. Augustine, *Stenotaphrum secundatum* (Walt.), Kuntze.
Melaillo, *Panicum glutinosum*, Swartz.

During the first year a quick grass covering is needed to prevent surface soil washing while the permanent vegetation becomes established. These quick growing native grasses promise to produce fairly good results:

Malojillo del monte, *Panicum laxum*, Swartz.
Carruzo, *Ichnanthus pallens* (Swartz), Munro.
Carrucillo, *Panicum trichanthum*, Nees.
Yerba de Madera, *Oplismenus hirtellus* (L.), Beauv.
Canutillo, *Lasiacis ruscifolia* (H. B. K.), Hitch.
Cerrillo, *Sporobolus indicus* (L.).
Straw grass, *Andropogon annulatus*, Forsk.
Yerba egipcia, *Dactyloctenium aegyptium* (L.), Richt.
Palmilla, *Setaria palmifolia* (Willd.), Stapf.

Echinochloa polystachya (H. B. K.), Hitch., *Hymenachne amplexicaulis* (Rudge) Nees, and *Panicum aquaticum* Poir., are grasses that normally grow on wet river banks, brooks, marshes, and shallow water, but they have been tested for growing under dry upland soil conditions, and have shown to adapt themselves to such dry-land conditions quite satisfactorily. They grow over 8 feet long, with culms spreading and producing roots at the nodes. They are therefore promising new grasses for erosion control, besides being relished by livestock.

Grasses Suitable for Controlling Erosion in Diversion Ditches, Levees, and Road Banks

Grasses adapted for use in diversion ditches should be of the fine growing type to retard the flow of water to a suitable minimum degree. These grasses should have a decumbent growth and be stoloniferous with extensively netted root system so as to prevent scouring by the water at the bottom and sides of the ditches.

Those grasses already mentioned for use in outlet channels and terrace banks can be successfully used for diversion ditches as well as for levees and road banks. In addition, there are some comparatively tall grasses that can be used with fair results for road banks. These are:

Malojilla, *Eriochloa polystachya*, H. B. K.
Molasses, *Melinis minutiflora*, Beauv.
Malojillo del monte, *Panicum laxum*, Swartz
Panicum adspersum, Trin.

Grasses Suitable for Controlling Sheet Erosion

This type of erosion wherein the surface layer of good soil is washed away by run-off water in a uniform sheet is one of the most destructive. It is noticed only when the soil is almost ruined, and the subsoil is beginning to appear at the surface. It can be checked in time by planting and sowing various highly stoloniferous grasses, with abundance of growth above ground to prevent the direct beating of the rain against the soil. Grasses should be chosen that will add considerable organic matter to the surface soil to increase its water absorbing capacity. They must be quick cover-forming grasses and possess an abundance of deep, netted roots at the main stems and at the nodes. And, in Puerto Rico they must necessarily be of some economical value. Puerto Rican grasses tested and found to have the required characteristics are given below:

Molasses, *Melinis minutiflora*, Beauv.
Para grass, *Panicum purpurascens*, Raddi.
Malojilla, *Eriochloa polystachya* (H. B. K.), Hitchc.
Pata de gallina, *Digitaria horizontalis*, Willd.
St. Augustine grass, *Stenotaphrum secundatum* (Walt.), Kuntze.
Sour grama, *Paspalum conjugatum*, Bergius.
Carpet grass, *Axonopus compressus* (Swartz), Beauv.
Malojillo del monte, *Panicum laxum*, Swartz.
Yerba de Madera, *Oplismenus hirtellus* (L.), Beauv.
Straw grass, *Andropogon annulatus*, Forsk.
Matojo de Playa, *Sporobolus virginicus* (L.), Kunth.
Palmilla, *Setaria palmifolia* (Willd.), Stapf.
Pata de gallina enana, *Digitaria sanguinalis* (L.), Scop.
River grass, *Echinochloa polystachya* (H. B. K.), Hitchc.
Knotgrass, *Paspalum distichum*, L.
Hairy hen foot, *Digitaria villosa* (Walt.), Pers.
Bermuda grass, *Cynodon dactylon* (L.), Pers.
Melaillo, *Panicum glutinosum*, Swartz.
Pendejuelo, *Paspalum decumbens*, Swartz.
Arroz del monte, *Echinochloa colonum* (L.), Link.

Grasses Suitable for Pasture Revegetation

In Puerto Rico, most of the land devoted to pasture has been overgrazed for many years. As a result of this, sheet erosion, as well as gully erosion, has caused an impoverishment of such lands. Such lands and pastures should be furrowed on the contour and left to rest for a considerable period, and then reseeded or replanted to species of palatable native grasses that will serve the double purpose of checking erosion and providing forage or grazing. Native grasses adapted for such a use are here named:

Malojilla, *Eriochloa polystachya*, H. B. K.
Natal grass, *Tricholaena repens* (Willd.), Hitchc.
Molasses grass, *Melinis minutiflora*, Beauv.
St. Augustine grass, *Stenotaphrum secundatum* (Walt.), Kuntze.
Carpet grass, *Axonopus compressus* (Swartz), Beauv.
Short finger grass, *Chloris inflata*, Link.
Hairy grass, *Paspalum paniculatum*, L.
Malojillo del monte, *Panicum laxum*, Swartz.
Yerba de deo, *Chloris petraea*, Swartz.
Melaillo, *Panicum glutinosum*, Swartz.
Yerba dulce, *Paspalum plicatulum*, Michx.
Matojo blanco, *Paspalum virgatum*, L.
Palmilla, *Setaria palmifolia* (Willd.), Stapf.
River grass, *Echinochloa polystachya* (H. B. K.), Hitchc.
Aquatic grass, *Panicum aquaticum*, Poir.
Trompetilla, *Hymenachne amplexicaulis* (Rudge), Nees.
Ricegrass, *Leersia hexandra*, Swartz.
Knotgrass, *Paspalum distichum*, L.
Yerba de agua, *Panicum geminatum*, Forsk.
Sour grama, *Paspalum conjugatum*, Bergius.
Lovegrass, *Eragrostis ciliaris* (L.), Link.
Pendejuelo, *Paspalum decumbens*, Swartz.
Cerrillo, *Sporobolus indicus* (L.), R. Br.
Grama de costa, *Chloris radiata* (L.), Swartz.
Guinea grass, *Panicum maximum*, Jacq.
Hatico grass, *Ixophorus unisetus* (Presl.), Schlecht.
Rabo de ardilla, *Setaria vulpisets* (Lam.), Roem. and Schult.
Straw grass, *Andropogon annulatus*, Forsk.
Matojo de la arena, *Paspalum laxum*, Lam.
Yerba egipcia, *Dactyloctenium aegyptium* (L.), Richt.

Chemical analyses of these grasses are being made so that in revegetating an overgrazed field a combination of grasses may be formed according to the nutritive values of the species. A number of these grasses will be mixed and seeded in overgrazed pasture fields in combination with seeds of wild and cultivated legumes, and a sufficient rest period will be allowed in order to establish a permanent stand of grass vegetation.

A grazing plan designed to accomplish soil and water conservation, must be premised upon the proper use of those plant species which are being encouraged to grow and reproduce. Regardless of the proportion of these species to the total forage available, the rate of stocking must be based upon the amount of feed they supply, and management upon their particular requirements for growth and reproduction. In estimating the grazing capacity, all other species should be rated accordingly.

—Liter E. Spence.

III

Soils, Soil Conditions, and Their Relation to Erosion-Control Practices, Cayey Area

By Samuel Gracia

THE CAYEY AREA, as discussed in this paper, includes most of the municipalities of Cayey, Aibonito, and Cidra. These are in the central part of the island, in the Cordillera Central, a chain of mountains extending from the northeast to the southwestern part of Puerto Rico.

The area is well supplied with a network of insular roads connecting the three towns and extending to other parts of the island. There are also many municipal roads and trails which connect the towns with the rural zone.

The region is hilly and mountainous, with a few small valleys and terraces. The slope classes vary from 8 to 20 percent in the low relief soils, as the Toa, Mabí, and Torres, and from 20 to above 60 percent in the high relief soils as the Múcara, Jácana, Catalina, and Cialitos. The average slope for the last group of soils is around 50 percent.

The largest and most important river of the area is La Plata River, passing through Cayey, Cidra, and Aibonito, running north and flowing into the Atlantic Ocean. Most of the smaller rivers and brooks of the area are tributaries to La Plata. This region has a mild, cool climate most of the year. The average rainfall during the last 20 years has been approximately 56 inches.

Agriculture is the chief industry of the area. Tobacco and sugarcane are the leading crops with some coffee, pineapples, and minor crops in second place. Sugarcane is cultivated chiefly in the best soils of Cayey and Cidra. There are two planting seasons, one from January to May, known as spring planting, and the other from July to October, known as fall planting. Central Cayey grinds all the cane grown in the area. It is a small mill, having a grinding capacity of about 800 tons of cane per 24 hours. The grinding seasons last from January to May.

Tobacco is grown in the hilly and mountainous lands, with a few terraces and alluvial soils planted also. Growing season lasts from October to January. Such minor crops as beans and corn are planted after the tobacco is harvested. Múcara are the soils most used for tobacco growing.



General view of bank control experiment, showing terraces on the contour and grass plantings 2 months old. Bermuda grass in the center has developed much more rapidly than St. Augustine and centipede grasses on the left.

The principal soil series found in this area are Múcara, Catalina, Cialitos, Mabí, Jácana, Torres, and Toa.

Múcara soils are the most extensive of the area. They are derived from rocks of cretaceous age, most of which are igneous rocks predominantly andesitic. Múcara soils of this region, especially those devoted to tobacco, are usually shallow to rock. They are characterized by a dark grayish-brown to brown topsoil to an average depth of 6 to 8 inches. Intermingled with this layer is a high percentage of rock fragments. The surface soil does not usually rest on solid rock but passes by degrees through a broken mass of partly disintegrated rocks to the solid rock bed below. The depth of these soils varies from 4 to 8 inches on the ridge tops to 8 to 14 inches on the slopes.

Catalina soils in this region are found in the northeastern part of Cidra, in the eastern part of Cayey and in the central and northwestern part of Aibonito. Catalina soils are derived from andesitic tuffs. The topography ranges from rolling to steep, yet most of the hills are rounded with gently sloping ravines. The topsoil ranges from light red to reddish brown. The depth of the surface soil varies with surface relief. On the steeper, more eroded slopes, it does not average over 4 inches deep and when plowed some of the subsoil is turned over. In the more rolling, less eroded areas, the surface is usually about 8 inches thick. The subsoil is a reddish-brown or light-red, slightly heavy, but friable clay. Roots penetrate it readily and water percolates rapidly, thus erosion is less severe than if

the soil were more plastic. At a depth of about 24 inches the soil becomes a deep red clay which is even more friable than the layer above but has less structure. This red clay continues to great depths and changes very little. Catalina soils in this region are devoted especially to sugarcane, pineapples, and minor crops, although some tobacco is grown in them.

Cialitos soils occur associated with Catalina. Topsoil ranges from light grayish brown to brownish red in color and passes into a yellowish-brown to light-brownish-red clay, having a slight tendency in places to have a mottled yellowish-brown and light brownish-red color. This shows that under drainage is not as good as in the Catalina soils, as they are not mottled. The depth to rock varies greatly in a short distance; in places it occurs at 30 inches while in other places it may be over 10 feet. In places the subsoil may be quite yellowish and have rock fragments through the profile area into the surface. In other areas the surface is very shallow due to sheet erosion. There are some sites where the reddish-brown subsoil may continue to a depth of 30 inches before the friable yellowish-red lower subsoil begins. Cialitos soils in this region have practically the same use as Catalina, when they are good Cialitos. Poor Cialitos are used for pasture.

Mabí soils are developed on low colluvial slopes or terrace-like positions of the Múcara soils. Mabí soils have a grayish-brown, in some cases almost black surface soil which is usually heavy and plastic when wet, but which works up into good tilth if handled properly. The surface soil is usually over 8 inches deep and quite fertile. On dry speels topsoil usually cracks. The subsoil is a yellowish-brown, plastic, heavy clay streaked moderately with rust yellow and brown. This layer gradually changes at a depth of 30 to 40 inches to a friable, brown and yellowish-brown silt loam which crumbles easily between the fingers. This grades into disintegrated rock material similar to that found under the Múcara soils. Fine, whitish specks of rock material occur in all layers. Mabí soils are slightly acid. The surface relief is smooth to slightly undulating. On the more level areas drainage is imperfect and is a difficult problem; even with ditches, water may become stagnated before it percolates through the deep, plastic, sticky clay subsoil.

Most of the Mabí soils of this area are devoted to tobacco and sugarcane. Plantains seem not to do very well on Mabí soils.

Torres soils occur on terrace positions very frequently adjacent to streams. The topsoil has a brownish-gray to brown surface about 8 inches deep, underlain by a light-red or reddish-brown, moderately fine

silty clay streaked more or less with yellow which gradually changes to a friable reddish brown, and in places red gravelly loam or clay loam to a depth below 3 feet. In most places rounded gravel occurs throughout the profile. All layers are quite acid. Exposures indicate that the soil is stratified. There may be several gravelly layers in the deeper deposits, and in places they have undergone sufficient weathering to form layers similar to the Catalina clay.

Jácana soils may be considered as very deep Múcara soils. They are derived from tuff and occur on gradual slopes below Múcara soils and in its concave slopes. The topsoil has a dark-gray to brown color and varies from 6 inches to about 1 foot in thickness. This passes more or less gradually into the yellowish or reddish-brown subsoil which in most cases consists of clayey material with a large quantity of sharply edged and partly rotten rubble. Jácana, Mabí, and Múcara are associated soils.

Toa soils are not abundant on this region. These soils have a brown to yellow-brown, well-oxidized soil material over a yellowish-brown alluvial subsoil. No heavy B horizon is present. Occasionally, slight mottling is found below 30 inches depth. Toa soils are usually very fertile, excepting the sandy types.

Sheet erosion is quite severe in this area. About 50 to 75 percent of topsoil has been removed. Múcara types are the most seriously eroded and in places barren rock is found in these soils. Catalina and Cialitos show considerable sheet erosion but not so deeply as the Múcara, Mabí, Jácana, Torres, and Toa which show less erosion due to their lower surface relief. The table shows the percentage of erosion found on the soils of La Plata Farm, Cayey area, Puerto Rico.

Soil series	Erosion class					Total acres
	0	2	3	33	4	
	Percent	Percent	Percent	Percent	Percent	Acres
Múcara.....	1.64	3.04	81.22	374.00	45.07	504.97
Mabí.....	5.73	7.66	126.94	29.28	.....	169.61
Jácana.....	.....	.....	22.50	14.41	.....	36.91
Toa.....	.....	2.51	.....	.....	.....	2.51
Total.....	7.37	13.21	230.66	417.69	45.07	714.00

More than 1 billion and 54 million acres of land in the United States is farm or ranch land owned by private landholders. This is more than four times as much as is included in Federal and State forests, parks, and game refuges, and is fully 55 percent of the land in the country.

Late Publications Treat Land-Use and Related Conservation Problems

For **REFERENCE**
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

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KUDZU



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE • WASHINGTON



This Issue:— Soil Conservation Districts in
June 1939 Georgia and Arkansas

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The author takes this opportunity to express his appreciation for cooperation received while gathering material for this article. The style and angle of its writing prevented the inclusion of names and titles of officials, with few exceptions. A straight reportorial job, this article has dropped its credit lines mostly by inference, has without deliberation omitted many citations which would properly belong in a manuscript stressing administrative set-ups or techniques. The Office of Land Use Coordination, for example, has a primary responsibility for the success of soil conservation districts, although it does not share actively in the physical operations in the field.

Worth noting is the fact that the following States have enacted soil conservation districts laws: Alabama, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin.

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WELLINGTON BRINK
EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

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H. H. BENNETT
Chief, Soil Conservation Service

JUNE • 1939

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

TAKING firm root in rural America—spreading like a healthy kudzu vine—is a new concept of land use. Rarely, if ever, has an agricultural principle or program or philosophy germinated so surely, so quickly, or in so many environments. Down the dusty aisles of cotton it seeds and propagates; out across the amber wheat belt and in the tasseled corn, up hundreds of winding country lanes, along the interminable barbed fences of western ranches.

Ideas are trail-blazers of human progress. Ideas, as distinguished from things. And it is a pioneer idea—an idea which states the logic and traces the broad pattern of a permanent husbandry—which has its blueprint in the soil conservation districts.

The mechanics of soil conservation districts have been discussed too frequently, are now too well understood, to warrant repetition here. Special legislation recently enacted in 35

new patterns of land use in two southern states... by wellington brink

States gives to such districts the status and the facilities they require to function, and opens the way to better land use through considered planning. Wherever there are districts, they are the creation of the farmers—the tenants and the owners—within their borders. Districts follow the democratic tradition; their impulse, their existence, their direction and control are at the crossroads ballot box.

HOW does the district idea work out, as it moves from theory to practice, from paper to farm?

In one form or another, the question repeats itself. A train window frames the wayside ravages of erosion, an automobile passes a demonstration farm with grassed waterways, contoured strips and curved terraces. More often than not, discussion thereupon turns to the necessity of better land use to the future of the whole people.

But can farmers cooperate among themselves? is asked. Will they avail themselves of sound technique? These are two important requisites to the success of the district program.

In search of answers, I went to Arkansas. And then I went to Georgia. These two States got off to an early start in the great experiment. Each is an agricultural laboratory of varied soils, topography, economic and social conditions. Each has its problem areas, its

prosperity zones. In April I spent two weeks talking with farmers, with county agents, with bankers, with district supervisors. I tramped along terraces and pasture furrows, walked knee deep in crimson clover, climbed over wire and rail fences to examine the mending effects of kudzu, lespedeza, and Bermuda. Here in the soil conservation districts of Arkansas and Georgia I saw not only the farmer at the plow handles but the forces at his side.

I SAW money being loaned by the Farm Security Administration, so that the tenant farmer can pay a few years' rent in advance, and the landlord, in turn, can finance long-time soil-improvement measures and pay for house repairs and new barns.

I saw county agents working out Triple-A payments for permanent conservation work.

I saw Smith-Hughes teachers, newspapers, chambers of commerce, county commissioners, pushing the educational phase, making of the district an all-community enterprise.

I saw Civilian Conservation Corps planting trees, building check dams, putting roads in usable condition, protecting them from future washing, making markets readily accessible to small homesteads in the hills.

I saw Soil Conservation men "running lines," writing agreements, giving technical assistance and leadership.

THIS article purposes to be an eyewitness account. And because I do not think too rosy a picture would serve the cause of better land use, I shall not try to depict a millennium. Time, space, and cash income are hard, uncompromising factors. Human engineering is at least as imperative as the handling of levels and transits. Costs of planning farms are said to run too high at times. The writing of farm agreements may take too long. The educational program has been known to lag or to bog down. Here and there, farmers seem to expect to be supplied field labor at Government expense. Heavy pieces of equipment—fresnos, terracing plows, ditchers—are not everywhere at hand. Impatience is a tendency: failure to comprehend the long-term benefits, unwillingness to wait for cumulative results. We might as well acknowledge some of the valid doubts and obstacles and criticisms and then proceed to some running notes reflective of present progress.

the arkansas testing grounds

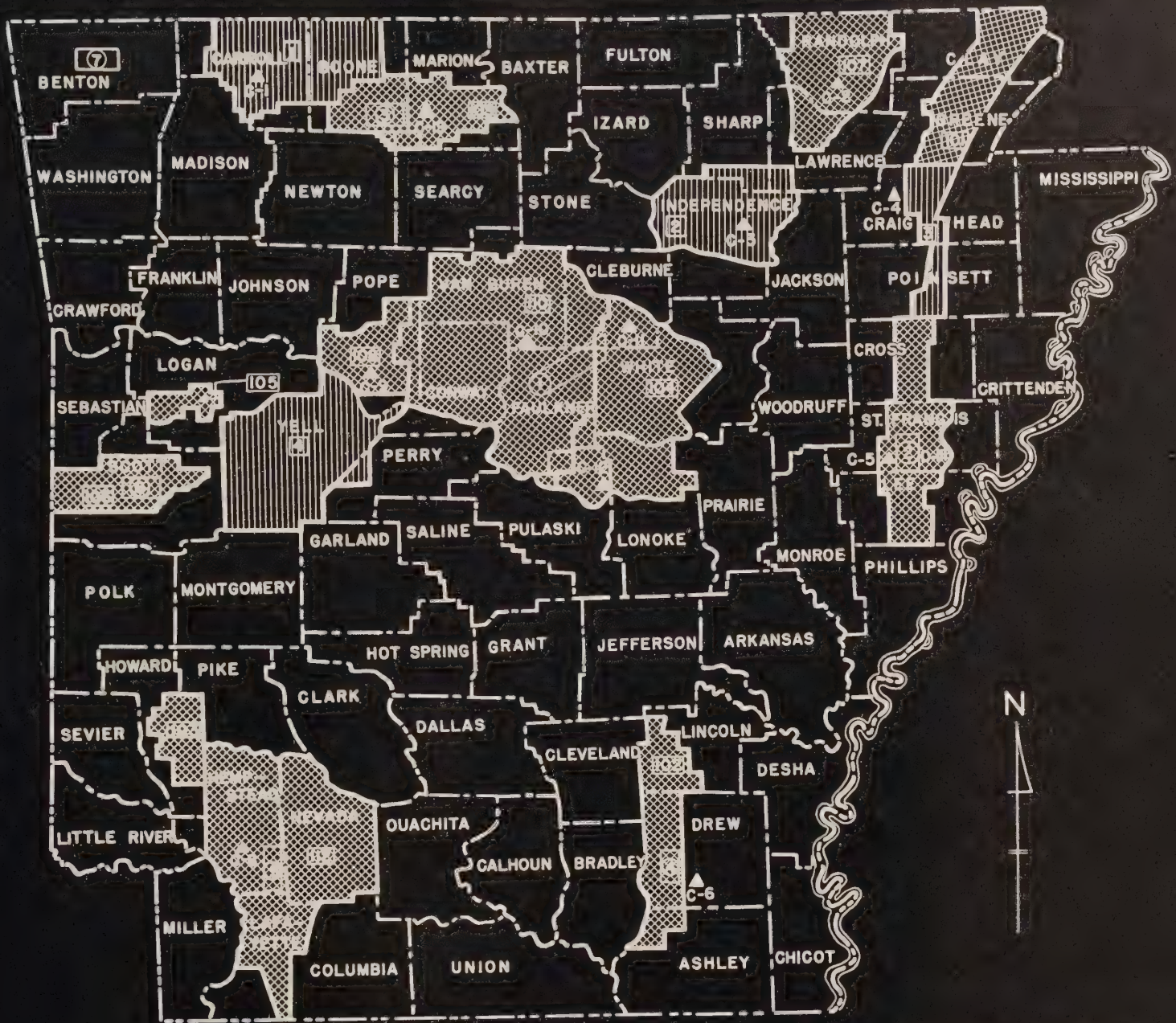
SCENE of much spring activity was Arkansas. Ten of the districts had been going just about a year. Three others, approved, were ready to start. More than a million acres had already seen the completion of conservation surveys, and 1,422 farms had been planned by the Soil Conservation Service.

Districts run small in Arkansas. Tiniest of all—and among the first to organize—is Magazine, commanded by a mountain of that name, in Logan County.

Magazine is characterized by abrupt, knife-like

ridges which roughly parallel each other from southwest to northeast. These ridges create unusual water-disposal problems for farmers who till the intervening valleys. Reveille Creek, draining the principal watershed, heads in a high, billowing country now being controlled by the Magazine Mountain Resettlement Administration project—one of the largest projects of its kind in the South. The stream, as a usual thing, runs placidly between the sharp valley walls. Dogwood blooms along the way. And the native vegetation is of a variety to delight an artist and attract the interest of a botanist. Of trees, there are half a dozen kinds of oak, an abundance of short-

ARKANSAS



 DISTRICTS APPROVED
NOT OPERATING

- 1 Kings River Osage
- 2 Moorefield
- 3 Craighead Poinsett
- 4 Fourche-Pettit Jean

 OPERATING DISTRICTS

- 101 Green County-Crowleys Ridge
- 102 Lower East Saline
- 103 Mine Creek
- 104 East Central
- 105 Magazine
- 106 Poteau River
- 107 Tri River
- 108 Illinois Bayou
- 109 Crooked Creek
- 110 Central Valleys
- 111 South Crowleys Ridge
- 112 Terre Rouge-Bodcau

 SOIL CONSERVATION
C.C.C. CAMPS

- 1 Berryville
- 2 Pocahontas
- 3 Charlotte
- 4 Jonesboro
- 5 Forest City
- 6 Monticello
- 8 Hope
- 9 Shiloh
- 10 Damascus
- 11 Heber
- 12 Jacksonville
- 19 Eros

 SOIL CONSERVATION PROJECTS

- 1 East Cadron Creek
- 2 Crowleys Ridge
- 3 Crooked Creek
- 4 Monticello Ridge
- 5 Bodcau Creek
- 6 Poteau Valley
- 7 Osage Creek

leaf pine. There are ash, sycamore, gum, elm, sassafras, persimmon, walnut, hickory. And of shrubs, the colorful sumac, French mulberry, buckbush, huckleberry, blackberry, buttonbush, wild rose, redbud, and wild plum. Grasses, too, in some array—including blue-joint turkey foot, Indian, broomsedge, nimblewill, switch, three-flower melic, smooth crab, purple top, little bluestem, small cane, yellow bristle, Dallis, and Bermuda. Yes, Bermuda, concerning which more will be said later.

But here as elsewhere, the plow, straight furrows, row crops, haphazard farming have nullified the natural advantages. Woods and meadows and pastures have known the horror of the match. The axe has cut too wide a swath. Pastures have been asked to feed too many cattle, bear up under too many hooves. Under such circumstances, accelerated by a rainfall that is high and a soil whose water-holding capacity is low, sheet washing has ensued and gullies are numerous. The first signs of economic dry rot were already beginning to appear when the district began its work. State Senator Charles X. Williams, stalwart conservationist, stated at a farmers' meeting recently that he had not seen a new wagon on the streets in 10 years.

To attempt to check the damage and to ensure the future of the valleys called for more than a hop-skip expedient. One farm, it was felt, might terrace and strip crop and revamp on a grand scale, and still not materially alter the general picture. Soils would keep on losing productiveness, minor floods would recur at the usual intervals, stock would get thinner and scragglier, farm buildings would go unpainted, population would gradually slough off, and taxes would become harder to collect. Moreover, the one farm that did its work with an eye to both present and future might find itself handicapped by the lack of conservation measures on some neighboring farm. The problems were not of a single-farm stature—they reached out over the watershed and the trade territory of the town of Booneville.

The proposed district idea looked big enough and feasible enough to merit a trial. From talking with numbers of farmers themselves, and also with local business men, I received the definite impression that sentiment for a soil conservation district sprang spontaneously from the so-called "dirt" farmers themselves. The law which opened the way was passed in March 1937 and did not become effective until the following June. But as early as July came a hearing, in October a referendum and in November the granting of a charter. A district work plan was evolved by the

district supervisors with the help of the State Extension Service, the Soil Conservation Service, and the State Soil Conservation Committee. A memorandum of understanding for active Soil Conservation Service assistance was approved in February 1938 and by March 1 the district began its practical functioning.

The nearest C. C. C. camp was 61 miles from the district. There was little heavy farm machinery in the community. But there came 135 applications for technical services. Conservation surveys were soon completed on 270 farms. Ninety of them came under agreement, and 90 percent of these swung promptly into the program. They used manpower and mulepower. Sweaty, homely manpower and mulepower. The work was aided by technicians, a steady educational drumfire, and the momentum of an aroused community wakefulness. Broad-based, modified Nichols terraces, pasture furrows, diversion ditches were installed. On 68 farms, 652 acres went out of cultivation. On these farms 4,000 acres were added to pastures, to meadows, to woodlands within the first year.

Costs of technical planning? A check-up on nine farms showed an outlay of but 9.4 cents per acre on 4,900 acres for this phase of the work. An outlay which the farmer himself did not pay and which constituted a permanent district investment.

E. L. Mikles, one of the district supervisors, now sees a future in the land. Ten-foot gullies were ripping through his place a year ago. Now they have been sloped and matted with Bermuda grass. I couldn't see a sign of them as I walked across the fields. Diversion terraces have been constructed to handle the heavy discharges of water from a large drainage area. One soggy spot of ground kept out the Mikles plow until too late in the season for planting. Mikles was confronted with the prospective loss of \$200 in A. A. A. payments. He carried his problem to his county agent, who showed him how he could make up the amount by building water-disposal structures and instituting other conservation measures of permanent character. His experience typifies the cooperation between agencies in the Magazine district.

The Rotary Club lunched, heard a young fellow tell how vocational agriculture courses are helping to spread the doctrine of better land use and better living. Afterward, a newspaper editor, a wholesaler, a banker, and a farmer-cooperator—members of a business men's subcommittee on district activities—met with me in a nearby courthouse. Someone pulled out a scrapbook of local press clippings telling the day-by-day story of district organization and accomplishments.



Another recounted the yeomen services of the editor and his wife, in preparing town and country for the new program. The nearest soil conservation demonstration project, it seems, is at Waldron, 31 miles away. And the curved farming, slowed waters and climbing yields at Waldron constituted the show window which really sold the idea of a district to the farmers of Magazine. As far back as 1936 Editor Max Hampton and Mrs. Hampton did a little voluntary promotional work, conceived a free tour to the show window. Going 50-50 with the Booneville Chamber of Commerce, they personally paid half the expenses of sending over six bus loads of visitors for a look at the new methods. The Waldron project has continued ever since as the working model for the district.

John Williams, banker: "General planning in this community is going to bring us more cotton on fewer acres. Grass and conservation of the soil will lead to a better class of livestock. And the district will encourage our farmers to do more grain feeding . . . Now, if a farmer comes in for a loan of \$100, our bank may ask him to borrow enough more to buy some needed dairy cows."

W. L. Fulmer, merchant: "Magazine district farmers measure their costs not in dollars but in time. Ledgers are balanced in terms of man-hours and mule-hours, for the farmers do the job themselves. . . . In the past we have had various high-pressure, ill-advised rural movements—strawberry booms, bean campaigns, highbred Jersey cow ventures—which have failed because we lacked canneries or stable markets or were otherwise unready. The district program, on the other hand, appeals to us as being broad based, long term, sound. It is an all-farmer program, with nothing furnished except the technical supervision. We can afford to wait a few years to enjoy its full benefits."

Hampton, the newspaper man: "What a setting for a conservation district! Why, the Bermuda grows so lush that it topples over at the top."

J. Alton Daniel, district conservationist: "The supervisors make no direct effort to encourage applications. They feel that farmers who solicit assistance as a result of work they have observed will be more determined in their efforts. We always have applications on file."

MINE Creek soil conservation district led the way not only in Arkansas but in the United States. The first hearing and the first referendum were held at Nashville. And the farm of U. J. Glasgow—under agreement No. 1—led the way in the district.

Here I saw progress average and representative of the headway that is being made under the new mode of farming. Glasgow built 1.3 miles of terraces this year, using only three small mules, a turning plow and a home-made drag. And he used a cover crop of rye and vetch on 16 acres. Much of his land was stripped with lespedeza in a rotation that included cotton-vetch-corn with a cover crop of vetch after the cotton.

Mine Creek—like most of the Arkansas districts—is small. It lies entirely within the bounds of Howard County. It is of but 88,500 acres, embraces Mineral Springs, Brewer, Nashville, Dillard, County Line, and parts of Buck Range townships. It is undulating to gently rolling, its elevation 400 to 600 feet. Rainfall is fairly well distributed but there are periods of hot, dry weather when crops on eroded, unprotected fields are sure to suffer. Its soils pigeonhole roughly as non-calcareous upland, old alluvial, and first bottom soils which are subject to overflows. There are shortleaf and loblolly pines, a few hardwoods, sweet gums and willows. In the forest openings are broomsedge, Indian grass, and carpet grass.

The main drive of the district is toward permanent cover, exclusion of livestock from woods, substitution of erosion-resisting crops for clean tilled on highly erodible acreage, rotation, vetch, rye and oats for winter cover and soil improvement, strip cropping, Bermuda grass waterways, liming and fertilizing, pasture management, woodland development, wildlife conservation, and the utilization of crop residues. Mechanical control extends to contour cultivation, terracing, contour furrowing or ridging, gully structures, and the protection of roads.

Glenn F. Wallace, chairman of the board of supervisors, is manager of one of the vast peach orchards that dot the district's slopes. We stopped to admire a

young bull that Wallace is getting ready to enter in a show ring, and to talk pasture developments. But his main concern was to show me the district's system of semicontour orchard planting in which allowance is made for strip cropping and terracing. About 300 acres have been planted in the Mine Creek district in accordance with this plan. One big orchardist now says that never again will he plant any other way. He loses fewer trees than before. The plan, which permits planting straight rows in one direction, can best be understood by reference to accompanying sketches.

Mr. Wallace has solid seeded the more erodible areas of his old square-planted orchards to lespedeza, a crop that does well on the orchard lands of Mine Creek district. He finds that he can maintain production without clean cultivation by fertilization, pruning, and proper management of cover vegetation.

District technicians hold that it is essential for erosion control and moisture conservation to plant an orchard on the contour, just like any other clean-tilled row crop. Most orchardists used the old block design so that they might cultivate in both directions to control weeds and insects. Using dry sprays, or even wet sprays, they would move their spray machines this way or that to conform to shifts of the wind. Cultivating in one direction only, they found it difficult to reach strips of weeds and grass between the trees. The new system of placing trees and terraces gives the advantage of straight rows one way—plus contour tillage, plus contour strips, plus terraces. Chief drawbacks are a slight sacrifice in number of trees, and the fact that the average farmer can't do the job without the help of an expert.

Fast approaching completion of its plan is the 180-acre farm of Joe Whitmore, 7 miles northwest of Nashville. Once creased by gullies—the worst a quarter of a mile long and 10 feet deep—this property today boasts one of the finest terrace systems and some of the greenest meadows and pastures in the whole countryside. The meadows and the pastures benefit from the water dispersed from 6 miles of broad-base terraces which follow a serpentine course around the rocky slopes. Some of these terraces are 3,000 feet in length. The structures—lined out by technicians of the Soil Conservation Service—are the work of men and teams. In making them, Whitmore relied mostly on a plow with a long wing, which is a common property of the district. There's not a gully on the place today; they have all been filled in, terraced across, sown to lespedeza.

NOTE.—The author is the editor of SOIL CONSERVATION.

FIVE farmers sit at a table. Most of them have known each other for years. They have had to cope with identically the same droughts, late frosts, tight money, gully washers. They believe in the community, in the good earth. Long acquaintance has engendered mutual respect and confidence. These five are the elected governing body—the district supervisors—of this typically small Arkansas district. And because the district is small, they live within easy reach of one another, get together at frequent intervals, mull over the details of operations, exchange notes and suggestions.

Glenn Wallace tells the board about an experience of the past week. He had been disturbed by considerable losses of peach trees from a mysterious malady that attacked them “on the best farms, in the best orchards, under the best management.” So he wired Undersecretary Wilson—using, he stressed, his title of chairman of the supervisors. The very next day two pathologists from the Bureau of Plant Industry were down inspecting the trees, reporting their death as a result of freakish weather conditions. “There's a possibility,” said Wallace with satisfaction, “that we can forestall further losses of the kind by better control of moisture.”

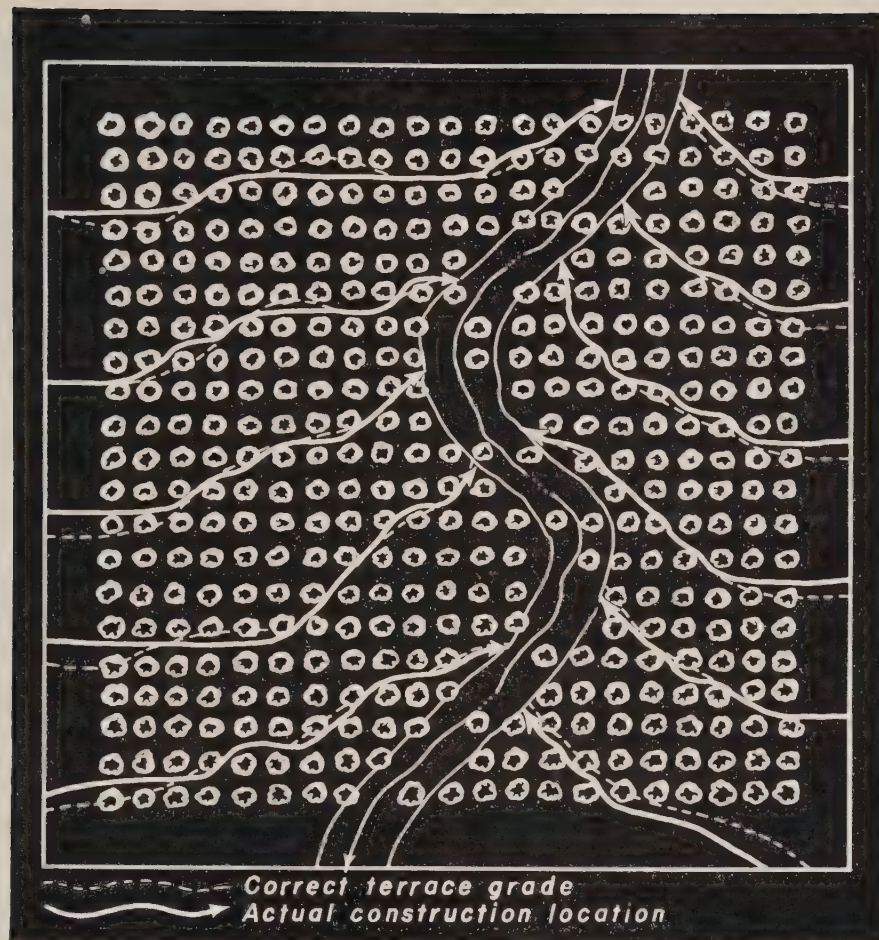
And now to the business at hand. Additional territory is petitioning for admittance to the district. A healthy sign, but the supervisors are inclined to proceed slowly with expansion. It is agreed to postpone a decision, and to exclude from consideration a large block of heavily timbered “flat woods” country which, it is felt, “would require mapping and would not greatly benefit under the district program.”

Someone reports the whereabouts of district-owned equipment, outlines the responsibilities of farmers making use of it. Another states that 158 applications have been filed, 71 agreements signed, and adds “If the time ever comes when applications slow up, we intend to hold more educational meetings. As it is, neighbors visit the farms where work is now being done; these farms are the district's best advertisement.”

In Howard County there is only the one plan, the one program, the one theme: Better land use. Gathered within the district is every local resource of technique, financing, and approach. One supervisor after another traced relationships, showed me how this agency and that fits into the whole, merges and blends its activities to achieve results.

“Each district cooperator was given his soil building allowance by the county A. A. A. representative,” noted one. “In consideration of this, a calendar of operations was set up to absorb the full allotment for carrying out the conservation plan on his farm.”

(Continued on p. 282)



This is the system of terraces that must be used on orchards that are set out in square blocks. The dash line shows the correct terrace grade and interval. The heavy solid line shows where the terraces must actually be located not to destroy any trees, which necessitates many small cuts and fills. Trees in the meadow waterway area will be left, but not replaced as they die.

About 300 acres have been planted in Mine Creek district according to this plan. The strips are located on the correct terrace interval and given terrace grade. Terraces can be built when trees are planted or at any time thereafter. With this system, there are straight rows in one direction. To take advantage of prevailing winds in spraying or dusting, travel may be done in the same general direction by proceeding along straight rows to ridge line or depression, and there transferring to contour rows or vice versa.



Pictures on Opposite Page

1. When he was an enrollee in a Soil Conservation Service C. C. Camp, C. W. Billings learned to apply conservation practices on the farms of others. Now he is a cooperater with the Magazine conservation district, installing conservation measures on his own farm 2 miles east of Booneville. Here he is constructing the dam for his stock tank.

2. Roy Milum is plowing under peas in a strip cropped field to add organic matter and plant food to the soil. Milum is a cooperater with the Crooked Creek district near Harrison.

3. A safe waterway in the making. The terrace outlet is being constructed with a fresno on the C. A. Barlow farm 2 miles west of Booneville, in the Magazine district.

4. Another view on the Barlow farm. Bermuda grass sod to form a soil-binding mat in the terrace outlet is being placed by the cooperater.

5. "As you measure to your neighbor, he will measure back to you," is a statement finding expression in Arkansas districts. E. C. Bowden, Booneville, and a neighbor pool their teams and labor resources to construct contour ridges on Bowden's pasture, 1 hour after he had signed a cooperative agreement with the district supervisors.

6. A virgin stand of yellow pine near Wilmar, 7 miles west of Monticello. District cooperators are planting new forests and learning to care for the old. This timber is in Lower East Saline district.

7. U. J. Glasgow, cooperater with the Mine Creek district near Nashville, goes into the field to begin the task of converting this eroding gully into a vegetation-protected waterway. The waterway will be sodded with Bermuda grass and overseeded with lespedeza after reshaping has been completed. It will be fenced in with pasture to be grazed and will serve as an outlet for water from a 25-acre strip-cropped and terraced field adjoining.

8. Contour cultivation and strip crops of winter oats control erosion on the N. D. Smith farm 8 miles west of Nashville. Smith is a Mine Creek district cooperater.

9. Strips of close-growing, fibrous-rooted crops make clean-tilled cultivation safer from erosion. Strips of rye and vetch on the contour filter out soil which is moved by water from the contoured cotton on the W. B. Piles farm at Waldron, in the Poteau River district.

10. Not only do strip crops help to keep the soil in place, but they also pay their way in fields of grain needed on many farms. Here oat strips are being cut on the O. L. Soloman farm in the Poteau Valley near Waldron.

11. Harvesting an alfalfa crop near Harrison, on the farm of K. Morris.

12. J. T. Cray, farmer near Harrison, prepares to spread lime over his fields as an aid to obtaining better vegetative growth on eroded land retired to pasture. Lime is procured from quarries on cooperators' farms. Crooked Creek district supervisors and the county agent have acquired a lime crusher which is operated mostly by farmers.

13. Making hay while the sun shines and keeping the farm at home when it rains is the dual purpose of this native meadow of lespedeza, little bluestem, sage grass and Indian grass. It serves as a source of hay and as an outlet for the terraces seen in the background. This farm belongs to W. D. Strain, Rosebud, in the Central Valleys district.

14. Land grown poor with fertility-sapping erosion and clean-tilled cropping needs to be fertilized and seeded in permanent pasture. Here the retired land on the J. E. Snyder farm, Forrest City, is being prepared for sodding. The practice of preparing a good bed for the sod is being followed in the Greene County-Crowley Ridge district in northeast Arkansas.

15. John Jenkins and a helper are shown constructing contour pasture ridges on the Jenkins farm 9 miles east of Booneville, in the Magazine district. These ridges will hold rainfall on the land where it falls, storing water to aid grass growth and help in flood control.

16. Sodding the ridges shown in picture 15.

17. Seventeen eggs in a quail nest on the O. L. Parkinson farm, 1 mile south of Harrison. The nest is in a black-locust plantation protected from fire and grazing. Wildlife management is a part of the Arkansas district program. Farmers take an interest in this phase of conservation equal to that accorded other phases of the program.

18. Cover and green manure crops play an important part. Here a cover crop of vetch and small grain is being plowed under on the farm of O. L. Parkinson, Harrison, in the Crooked Creek district.

19. The second generation watches the construction of contour ridges in a pasture near Bentonville.

20. E. C. Bowden and his neighbor "swap" labor and teams to get some sodding done.

ARKANSAS FARMERS AT WORK IN THE DISTRICTS



Flashes from the district scene: These varied pictures are visual evidences of the progress being made under the united program. Farmers themselves are doing the job, but they are making use of the whole range of facilities and techniques derivable from cooperating agencies. The idea is to safeguard the soils and utilize them at full efficiency.

(The mosaic is explained on the opposite page.)

Another explained that Farm Security clients are among those with agreements. They know precisely what to expect. Cotton, feed, livestock, canned goods—the specified production qualifies for the loan.

The Soil Conservation Service technicians, the county supervisor of the Farm Security Administration, and the clients jointly develop a farm plan. The Farm Security Administration representative becomes the contact man for the district supervisors, with such clients. He carries with him a copy of the soil conservation plan of each client's farm, is responsible to the supervisors for putting it into effect, looks to the Soil Conservation Service for aid in establishing erosion-control treatments.

The county agent and the home demonstration agent and the State Forest Service talk and think in terms of the district. Here, as in Magazine, average, self-reliant farmers make the decisions, adjust theory to practice, keep costs low by making use of the facilities at their elbows.

Said one good farmer: "We're not committed to an arbitrary policy. We regard the work thus far as exploratory, growing out of demonstration. We'll keep the district flexible in operation, introducing changes as we acquire experience."

recovery in crooked creek

GO WITH ME now to the Crooked Creek soil conservation district. Hewn out of parts of three counties, it lies high up in the Ozark country of northern Arkansas. We travel winding, tilted roads; ford swift-running, rock-bedded fingerling streams. Springs gush cold and clear out of the breasts of the mountains, inviting us to drink our fill. The woods are a plaid of many colors. The turns and twists of the trail are full of surprises. Broad sweeps of valley come suddenly to view, silver threaded with the fast-flowing creeks of the region—Crooked, Clear, Hampton, Greasy, Mill. Mountain waters which too often change to swirling brown, and break their banks to go on drunken orgies of destruction. The valleys are velvets green and bronze—but here and there vandal forces of erosion lately have torn at the tapestry, ripped the valleys end to end leaving them wounded and miserable. Gullies and the less conspicuous sheet erosion have made serious inroads on the beauty and productiveness of the land. And the same defective land use that has led to soil losses has also induced an unbalanced and abrasive farm economy.

The losses came slowly, and the recovery promises to be gradual. A new order of agriculture under the district plan can hardly classify as revolutionary because it comes as a natural, logical transition. M. A. Mears, tramping the furrows on a sloping field of his farm near Flippen, dramatizes the district idea. He carries two sacks instead of one, as he goes about his planting. Those two sacks symbolize a practice which a few years ago would have constituted rank agricultural heresy. He drops a few kernels of corn, and in the same furrow a few sprigs of Bermuda grass. It's the latest thing out here in the Crooked Creek vicinity. "The corn will pay for the work of establishing the sod," Mears explains. "And cultivation of the Bermuda encourages its growth. I got the idea from the Crooked Creek demonstration project, and the Soil Conservation Service technicians tell me it ought to work out well in developing my pasture program."

Nearby is J. H. Briggs, tenant. Under his new farm plan, he has recently planted 4,000 black locust trees furnished by the district. They are behind a new fence on a hilltop, and Briggs looks forward not only to better protection of the soil but to an increase in wildlife. He also has put out 30 acres in lespedeza.

Member of the Marion County Agricultural Program Committee is E. C. Walker, vocational agricultural teacher. Under his leadership 25 farm boys of high-school ages, are drilling in classes 5 days a week, sometimes also at night, on farm enterprises (small grains and forage crops), farm management, and farm repair work (fences and implements and so on). Each youngster carries on a supervised project program which divides into livestock, feed for livestock, and farm improvements (in which maintenance is particularly stressed). Wallace has 5 communities, finds that the county agricultural program short-cuts the educational preliminaries and reduces the number of meetings needed. He tells of interlocking relationships—of cooperating forces—schools, homes, Federal agencies, business groups—working with the farmer to weave a sound warp and woof for the district's land-use scheme.

G. E. Tanner, county agent, rides with us on a tour of the area; tells of the "absolute unity" of State Forestry Commission, Farm Security Administration, Agricultural Adjustment Administration, Soil Conservation Service, county school examiners, Extension Service, Farm Bureau, school superintendents, county judges, in bringing to a common focus the problems that beset the land and the people. He

describes the Agricultural Workers Club which meets at Yellville, lends vigor to the field attack.

Paralleling the ribboned highway at one point is the remnant of an old fence, the posts half buried by soil washed from higher land—unmistakable evidence of slipshod farming in the past. Superseding it are new posts, new wires—and in the fields beyond, a new mode of farming: symbol of better land use under the district idea.

Virgil Ott, farmer of Yellville, shows us the new mosaic being patterned on his sandy izzard soils—contoured fields with corn on the levels, strips of lespedeza sericea and oats, contour ridging on the exact level blocked every 50 feet to hold the water, broad-base terraces emptying into a recently scooped stock pond. Ott refers to the great, gaping, sawtooth gullies that have eaten at these very soils, says “Somebody’s got to do something or we’ll all have to move out.”

J. B. Milligan, farmer of Bruno, has been under the district plan since January. He has 17 head of cattle, is building toward 50. He is working out his salvation by curved cultivation, Bermuda, lespedeza sericea, Korean lespedeza, hop—following the lines of a plan which he will press to early completion. He is proud of a fine spring which flows down to Greasy Creek, furnishing a pure, sure supply of water to home and livestock. A trench silo is a valued recent innovation. “For years I have been a row farmer, but I want to get away from the mistakes of the past,” he told me. “I like the district idea. It looks to me like our only hope.”

Angling up steeply at our right is a 17-acre hillside pasture—one of the grandest pastures in the entire northern part of the State. It is a lush mixture of hop, bluegrass, Bermuda, and Korean lespedeza. The grade is so sharp that farmer, team, and implements actually tumbled downhill twice in the process of grooving contour furrows recently.

O. B. Pyle is owner of this farm and a leader in the Bruno community. He is district supervisor, a member of the executive committee of the State farm bureau, president of the local farm bureau. He regularly carries 70 head of cattle, knows the art of pasture management, watches the capacity of his grasslands, has a clear philosophy as to farm planning and district development. He referred to the expected location of a CCC-SCS camp within the district, thought it would prove useful in its usual capacity. “There are a few farmers, however, who have the impression that the camp will take the place of the district, instead of simply filling a supplementary role,” Pyle observed. “They’re waiting for the camp to



Bermuda grass and corn are agreeable bedfellows on many Arkansas farms. The corn in this picture had been cultivated four times with small shovel plows and “laid by” with a small turning plow. A yield better than the average resulted.

move in before they get down to work. As a supervisor, I am going to see that the camp gives help to those who help themselves; the farmers who are already actively cooperating will get the first assistance. There’s a big job to be done here in the Crooked Creek district. We can’t hope to get it done unless we all pull together.”

We drive down the main street of Bruno—a thoroughfare described as one which “never goes dry” because it is actually a shallow, gravel-bottomed stream fed by a big spring; stop to chat with J. B. Ewart, who has taught vocational agriculture in Bruno for 17 years. He is one of the strong cooperators who are “pulling together” for the success of the district. He personifies the busy teamwork that is seeking, through the district, to improve upon a farming regime which is accustomed to 16-cent butterfat, 12-cent eggs, 5-cent hogs, 12-cent broilers, and 6-cent beef; which hasn’t had a corn crop in 3 years; where 12 bushels is a good wheat yield, and where 20 bushels is about the top production for oats. Better oats were

introduced on Crooked Creek farms last fall, however—and soil conservation has come to stay.

Of the many significant shifts in trend which soil conservation districts are bringing to Arkansas, none is more amazing than the development of pastures and meadows. Bermuda grass—once regarded as the farmer's pest—is now the farmer's friend. Its uses are many, and its popularity is spreading wherever there are gullies to be mended, waterways to be established, grazing to be supplied, restless soils to be blanketed against loss. In certain quarters there is a feeling that the pastures could easily get ahead of the livestock. But in Harrison, Boone County, the bank, railroad, public utility, and chamber of commerce recently set up a revolving fund of \$1,000 with which to purchase purebred bulls, cows, and heifers as a nucleus for the expanding livestock industry. At a meeting of the Agricultural Workers Club, O. L. McMurray, county agent, told of bringing in 35 animals, mostly Jerseys, which were resold on convenient terms to farmers of the community.

Kaleidoscopic notes from the Crooked Creek scene:

John Pearson, Everton farmer, writes to the district conservationist: "She holds water like a jug, so the contours are the dip."

T. C. Morrow, Yellville farmer: "My land is better than it was when I changed my method. Land on which rows are still going up and down hill is still 'going down hill' in production. Our land was not put here to wash away. If we do not take care of it, it will soon have to be retired and nature will have a real job putting something back which we destroyed. My experience has taught me that check-plowing corn is not necessary to control weeds and grass. Corn planted on the contour slightly below the level in a furrow can be cleaned without plowing both ways. Fewer roots will be disturbed by plowing only one way. . . . I'm sure I get one-third more yield per acre by contour cultivation."

Walter F. Wood, farmer of Flippen: "If something is not done in this country, we will not have any land left to cultivate 25 years from now. Pastures, meadows, legumes, and livestock will save it."

An acre of land on the K. Morris farm, near Harrison, was once an eroded drainage ditch. Last year it produced 53 bales of timothy and alfalfa worth \$25. "The adoption of a soil-conservation program on my farm has made it possible for me to increase my livestock from 6 to 40 head and supply all the feed required to keep them." Mr. Morris is a cooperator of 3 years with the soil conservation demonstration project which prepared the way for the Crooked Creek district.

six brothers in central valleys

NOW, a swing through Central Valleys, largest of the Arkansas districts. Its arms arch out to include parts of five counties—Van Buren, Conway, Faulkner, Cleburne, and Pope. Here, repatterning 22,000 acres, we find 189 farmers seeking through better land use to control erosion, to keep more of the moisture where it falls, to plan their way to profits. They've made a beginning by taking 1,735 acres out of cultivation, adding 4,550 acres to permanent pasture and 514 acres to permanent hay meadows. Already they have banded 1,789 cultivated acres with strips of lespedeza and other soil-improving, soil-protecting crops. Forty acres have been planted for wildlife, and 3,273 once-idle acres are idle no longer. The district is receiving assistance from Soil Conservation Service technicians and from enrollees of Soil Conservation Service C. C. C. camps at Damascus, Heber Springs, Jacksonville, and Shiloh. As in other districts, the program is both a watershed and a community enterprise, backed by the combined forces of cooperation.

These farmers are protecting cultivated land from erosion by contour cultivation, strip crops, terraces, and crop rotations. Pastures are being improved by sodding alternate contour 30-foot strips with Bermuda grass; by overseeding with lespedezas and clovers; by contour furrows and ridges for retention of moisture; by fertilizing, and by removing sprouts and brush. Gullies are being plowed in and sodded. Woodlands are being protected from fire and grazing.

Six brothers owning 1,100 acres in the Pleasant Valley community north of Conway are among the farmers aggressive in advancing the district. This spring they pooled their team power and equipment, set a terracing record when they began installing conservation practices. In 1 hour and 20 minutes they completed 650 feet of terrace on Sam Wilcox's 240-acre farm, using 12 mules, 4 to pull the plow and 8 to pull a Martin ditcher. The terrace was of the channel type, 18 feet wide with an 18-inch channel. The carrying capacity will take care of any kind of rain that falls in this country.

These brothers—Sam, R. W., Morris E., H. B., Fred, and Ed Wilcox—all were among the early applicants for assistance from the district. They are using a wide variety of mechanical and vegetative controls. They used winter cover crops of vetch, which they plowed under this spring as green manure.



the georgia laboratory

WHERE flows the Savannah River, Eli Whitney in 1793 invented the cotton gin.

But Whitney gave to his adopted Georgia—and to the world—more than a new machine: He gave Georgia and the South a prosperity of pillared mansions, of surging industry, of busy seaports and singing rails; a picturesque and colorful symphony with Negro spirituals rolling across more and more whited fields.

But the agriculture born of the cotton gin flowered on a narrow stem. Always and ever lurked within the fluffy bolls a hidden danger. Cotton's quiet tread wore a hard path down through the years. Progressive Georgians sensed the hazards of single-cropping as early as 1810. In that year a handful of farmers incorporated the Agricultural Society of Georgia "to excite among their fellow citizens a desire of making experiments for the renovation of exhausted lands." And for 130 years Georgians wrestled with the problems of soil waste and a distorted agriculture. They joined rural movements, led cooperative attacks, pioneered in research and demonstration.

Not surprising, therefore, is Georgia's unified response to the opportunity presented by the district idea. Or that she is tackling the district program on a large scale. Districts run as large in Georgia as they do small in Arkansas. Whereas Arkansas thinks in terms of small watersheds and small communities, Georgia builds on large watersheds and county dimensions. The varied attacks of the two States illustrate the flexibility of the district plan.

Already—a bare 2 years after passage of the enabling act by the legislature—Georgia districts are crowding the map. To the districts the Soil Conservation Service alone has furnished an even dozen tractors, 34 ter-

racers, 15 drag pans—each item of equipment scheduled for weeks in advance, kept in top working condition, an incentive to cooperative effort. This Service, too, has supplied 24,000 pounds of lespedeza sericea seed, 855,000 kudzu seedlings, nearly 600,000 trees—direct contributions to the stabilization and improvement of soils. I found more than 135,000 acres under agreement, 6,000 acres of pasture contoured, more than 1,000 of the greenest meadow strips I ever have seen. Vast acreages of pasture lands have been seeded, fertilized. Ten thousand acres of new forest are pinning down farm corners that cannot so profitably be used any other way.

These and numerous other accomplishments come of the right kind of teamwork, and plenty of it. Framing and inspiring the land-use program in each county is a technical advisory committee—a meeting ground for all agencies concerned, with the county agent as presiding officer.

Teaming with the technicians is a farmers' advisory committee picked by geographical location and by crops; it studies survey, map, viewpoint of the technical group, offers recommendations to the soil conservation district ranging from retirement of acreage and discouragement of community pastures to other policies close to the heart of land use and development; gives the district the needed momentum. The county plan, therefore, springs from farmers, themselves—farmers availing themselves of good technical counsel.

broad river innovations

I WANTED to see how the Broad River district was working out its destiny. Eight counties cluster within its bounds—Banks, Stephens, Franklin, Hart, Madison, Elbert, Oglethorpe, and Wilkes. Substituting here for the close intensity of operations which I came to look for in Arkansas was a wide spotting of farmer activity with a decided trend toward adoption of practices—so-called "spread of practices"—in between.

For example, I learned of a farmer in Hart County—M. M. Norman, an honored "master farmer"—impatient to get under way, who wrote an excellent cooperative agreement himself, obtained its approval, and put his plan into effect. On his farm, I saw crimson clover meadow strips where gullies used to be. Not one farmer in many would be capable of doing as much or would essay a task usually calling for a specialist—but the path was open for the exceptional individual.

An innovation now in the test stage in the Broad River, Piedmont, Coosa River, and middle western



Dr. H. H. Bennett, Chief of the Soil Conservation Service, finds crimson clover does well on Georgia's famous "red hills." He examines a handful of this soil-building legume during a tour of Hart County in connection with the county's annual crimson clover festival, April 28.

Ocmulgee districts is a 4-day training course conducted by vocational agriculture teachers and Soil Conservation Service technicians.

I found the eight vocational teachers in Hart County important factors in district development. Here the Soil Conservation Service works out a program jointly with the teachers. Each teacher takes responsibility for the vegetative work on four farms—the kudzu, the crimson clover, the lespedeza, the trees, the pastures. That leaves the water disposal system to the Soil Conservation Service technician and gives him time to plan more farms than otherwise.

Active in accelerating district progress in the Franklin County work unit, Carnesville, is E. K. Davis. Davis, county agent, is an organization genius. He outlined the conservation attack, got up petitions. He called a meeting at Athens, summoned a good cooperator from each militia district—the smallest county unit—took pains to select those who had cars and could reasonably be expected to attend. These militia district representatives—there were 13, in all—incorporated, set themselves up as a county committee. Each committeeman drew up a list of 10 farms, suggesting the order in which they should be worked; the number was then pared to 3. The committeemen, supplied with the proper forms, conferred with their neighbors—their clientele—and came back with properly signed applications for service.

The county work unit thereupon obtained a tractor from the district which was on loan from the Soil Conservation Service. A committee was appointed

to look after the tractor, to assign and route it. The supervisors decided on a rate of \$3 per hour. Much time was lost, at first, trying to operate tractors efficiently; the solution was to bring in a technician of experience on the Athens demonstration project as inspector and director of terracing operations, and as instructor in the use of machines and implements—sometimes horse-drawn—throughout the district.

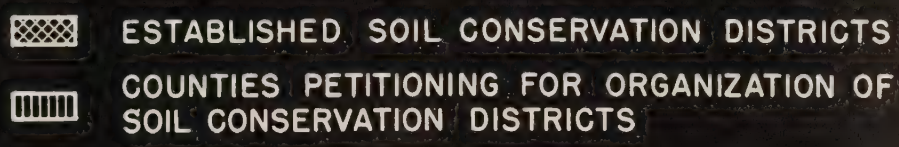
T. B. Thornton, Hartwell, led us knee deep through crimson clover which was at the point of bursting into bloom, said that crimson clover is one of the main reasons why Hart County today is almost deserving of the phrase "a dream come true." Two thousand acres of the Hart County work unit have been terraced. A district supervisor, this farmer avers that Broad River farmers "might"—he speaks the word tentatively—"might have gotten as much done in 20 years without the district as in 3 or 4 years with it."

Here in Hart County I was told of meetings held week after week by the Smith-Hughes teachers and representatives of F. S. A., S. C. S., A. A. A., Extension Service, R. E. A., Government lending agencies, and T. V. A. Each carried his problems to the meetings, fitted his segment to the district program as a whole.

Field after field was green in Hart County, green and safe from serious loss. Crimson clover mantled terraces and meadow strips on district farms. Crimson clover, and kudzu, and lespedeza, and Bermuda, season by season, are pinning down the soils, improving the soil resource, giving to northern Georgia an agricultural renaissance.

The talk hung around the subject of the crimson clover festival, which was soon to be held in Hart County, with music and barbecue, distinguished speakers, and visitors from miles around. In 5 years the State of Georgia has increased its plantings of crimson clover seed from 111,540 pounds to 2,837,350 pounds. This one stroke has done a great deal to change the rural panorama. Said a Hart County farmer, recounting a typical experience: "I have a small herd of dairy cows and find that it fits in mighty well when cover crops are grown. My cream check increased from \$4 per week to \$9 per week when the cows were turned in on crimson clover."

J. R. Westbrook, Ila, plants every third terrace interval in sericea. He has enough cattle to use it. His method is to seed Korean, 40 pounds per acre, in his wheat and oats. He cuts the grain, the lespedeza then comes on and reseeds itself. Westbrook is a good representative farmer; a supervisor of the Broad River district. He showed me where an old



ditch had been filled in and seeded with sericea. He pointed with satisfaction to a field of specially bred barley, a grain which he is using to replace corn on steep slopes. "Wildlife men," said he, "are having difficulty finding 'high class' gullies for their work on treated farms."

Lespedeza is also being planted in crimson clover on the Westbrook farm. Twenty acres are going into kudzu. Kudzu, too, is doing nicely for meadow strips on this farm. Loblolly pines are being set out on galled slopes. Oats and vetch are combined, mowed, fed. A road bank, once high as a man's head, has now been leveled, sown to lespedeza sericea; every bit of the land is being put to use. There were 40 white-face cattle 3 years ago; today, the same amount of pasture—but better—supports 85. There is more manure available, with which to increase the yields of crops.

FRANKLIN County is, agriculturally speaking, not only outstanding in the Broad River district but in the entire southeastern United States. The abrasive effect of erosion is clearly in evidence but the gullies are being filled, road banks are being sloped, sheet washing being arrested, and soils gradually being built back to productiveness. The policy that is being applied to such good effect in Franklin County is one which is being more and more generally followed throughout the district. Briefly, it outlines as follows:

Kudzu is planted in strips on abrupt slopes on cultivated fields. The next steepest and the worst eroded fields are assigned to lespedeza sericea in strips. This practice affords enough kudzu and sericea to supply the needs of the farm for hay. These two plants are deep rooted, and are not so susceptible to damage by the dry weather that can be expected in late summer.

Oats and barley are substituted for part of the corn normally grown for work stock, calves, and chickens. In all small grain an annual lespedeza is planted for seed production, soil saving, and soil building. It is, of course, plowed under. This assures hay from drought-resisting crops, and at the same time reduces

the acreage ordinarily devoted to clean-cultivated corn. The lespedeza seed and the small grain make two crops from the land and build fertility; the grain is cut high with a combine, and only the seed is removed from the lespedeza. All straw stays on the land.

piedmont district works back

HARD TIMES were an old, and a familiar story in Greene County. The land thinned and sickened, and its keepers wavered in their faith in its adequacy. The boll weevil came and half the population dribbled away under its impact. Houses went unpainted, unrepaired, began to lean on their foundations. Serious became the question of shelter for human souls, for livestock, and for crops. Schools and churches went to ruin. A problem area became Greene County; one of the worst areas of economic decay in all the South.

But a spark of initiative yet glowed to light the flame of big endeavor. From Greene County farmers themselves came the demand for inclusion in the Piedmont soil conservation district. With the setting up of this district, Greene, Taliaferro, Hancock, Putnam, and Baldwin Counties joined to prepare the bed of a new social structure. A county board of health was created as a result of the new impulse. The board of education and the county commissioners offered assistance. The W. P. A. undertook to erect school buildings in locations indicated by the densities of population. Came, too, not only the Soil Conservation Service but the National Youth Administration and the Civilian Conservation Corps. The Smith-Hughes vocational teachers and the Extension Service agents volunteered their services. Yes, and the Farm Security Administration.

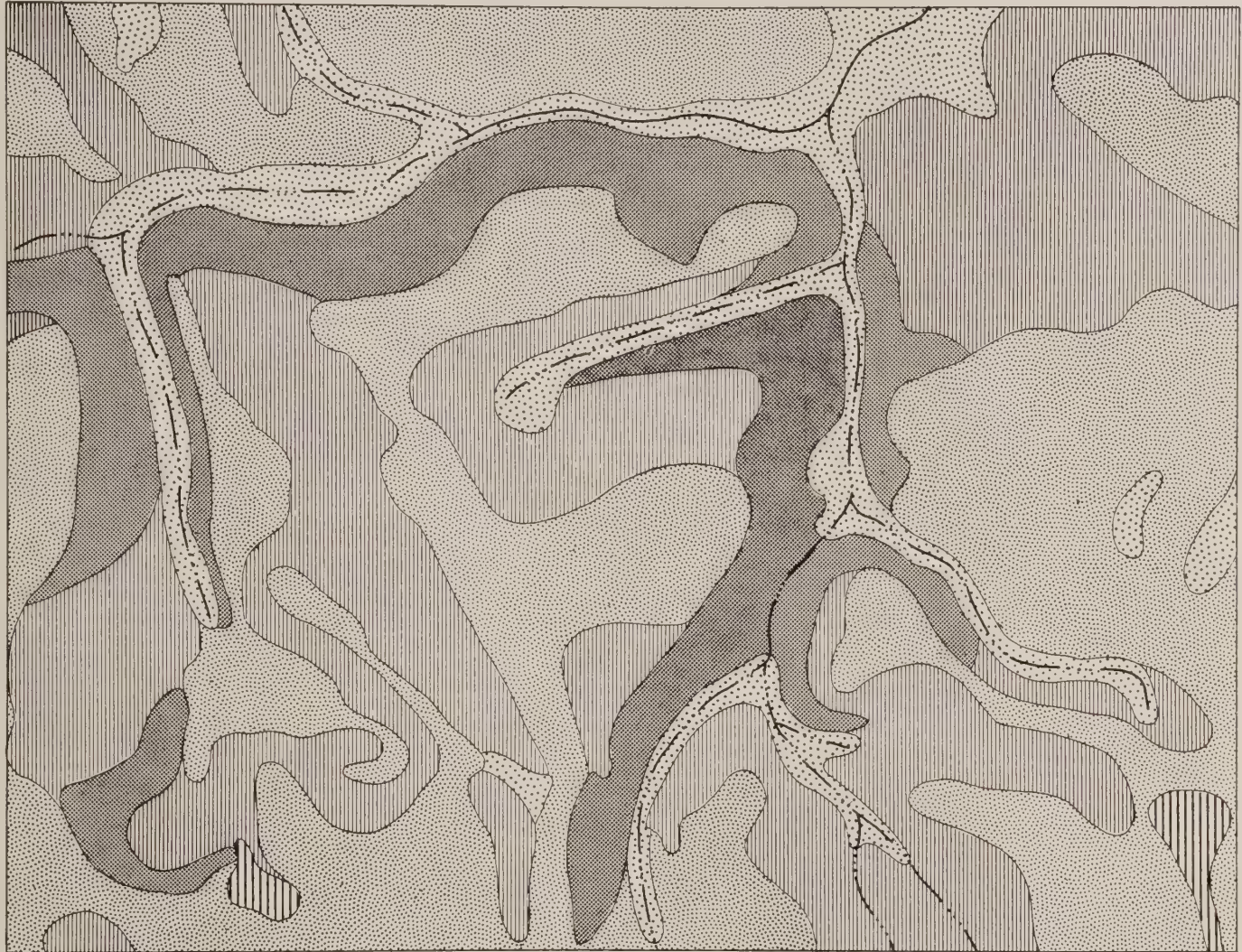
With me to Greensboro went R. L. Vansant, State director of the Farm Security Administration and Whitney Tharin, extension editor. Said Vansant: "The first farms in the district to be planned and put under agreement were under the wing of the F. S. A. They number 132."

We crossed the sleepy—always muddy—Oconee River: trunk line of erosion's freightage. Vansant

(Continued on p. 292)

Note.—Use-capability maps such as the one on the opposite page may soon be facilitating the work of writing cooperator agreements in soil conservation districts. They are readily interpreted by both farmers and technicians. Developed from conservation surveys and aerial photographs, the use-capability map brings together the available information on soils, slopes, erosion conditions and land cover. Certain practices and measures are known to be applicable to given sets of conditions and, by referring to detailed instructions accompanying each map, it is possible to determine which portions of a farm can be cultivated without hazard, which require simple protective devices, which demand the whole range of engineering and vegetative controls, which are suitable only for grass or hay, and which call for retirement to woods. First areas to be mapped according to use-capabilities are at Winona, Minn., and in Greene County, Ga. Similar maps are being developed for other sections of the country. Reproduced here in black is a segment of a much larger master map done in colors.

Piedmont Soil Conservation District Section of Greene County, Georgia



Scale in Miles
0 1/4 1/2 3/4 1

Classes of Land According to Use Capability

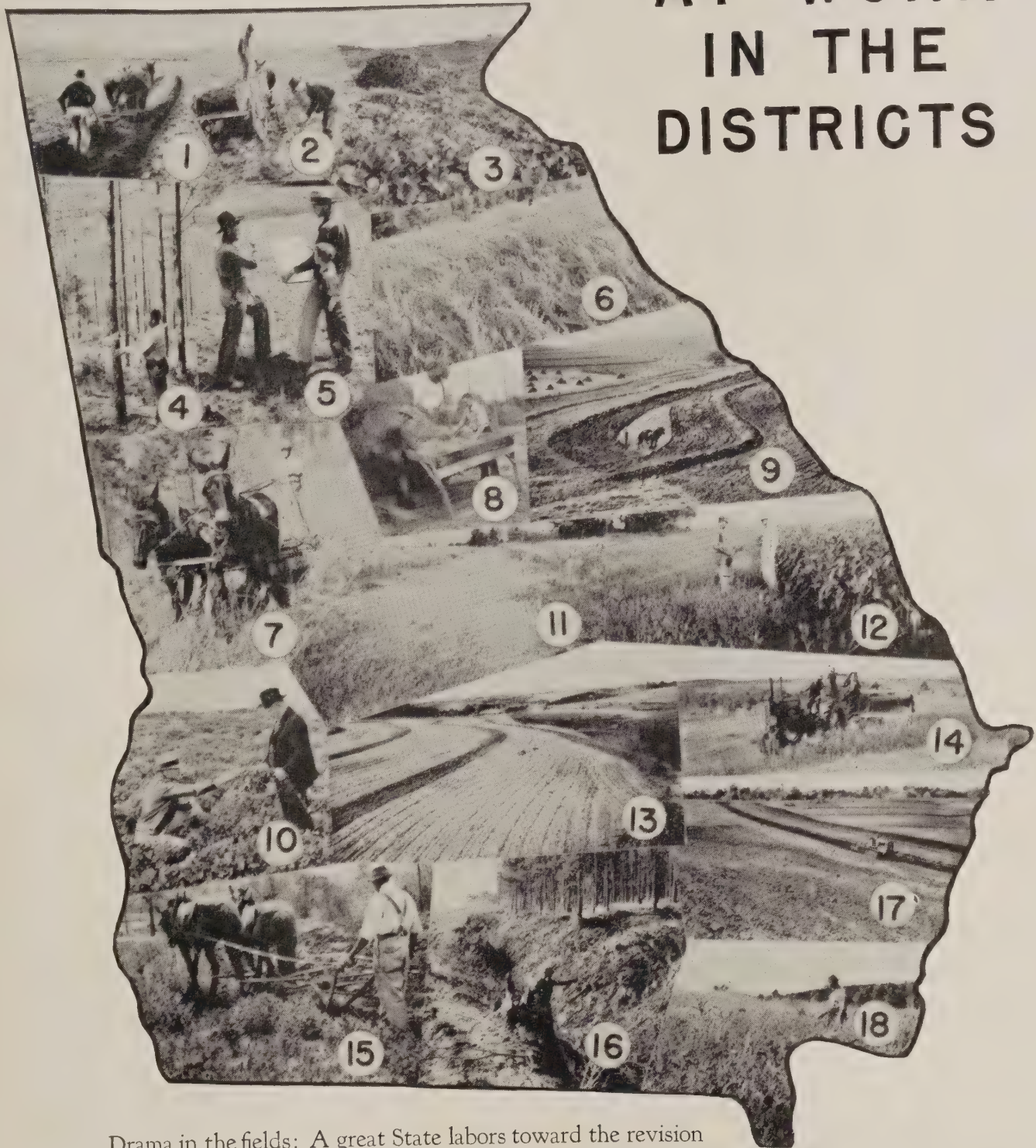
-  I Suitable for cultivation without special practices
-  II Suitable for cultivation with simple practices
-  III Suitable for cultivation with complex or intensive practices
-  IV Not suitable for continuous cultivation
-  V Not suitable for cultivation



Pictures on Opposite Page

1. Proper land preparation is the first step in getting kudzu established. Kudzu requires cultivation the first year or two.
2. Manure and superphosphate are applied as land is prepared for kudzu. Badly eroded soils usually do not contain sufficient plant food to produce an adequate cover.
3. Kudzu produces hay and forage of excellent quality, palatable and similar in nutritive value to alfalfa.
4. In the Georgia districts farmers consider their trees as a crop. In pioneer days, timber was something to be destroyed to make way for crops, but today they are vital to the farm economy as a source of fuel, fence posts, lumber, and cash income.
5. Farm planning for soil conservation replaces guesswork. It is better to know the best use for each area of land, as indicated by kind of soil, by slope, and by erosion conditions.
6. Lespedeza sericea provides continuous protection for severely eroded land. It also furnishes excellent cover and food for wildlife. Where harvesting is a desirable practice, good hay may be had from lespedeza sericea.
7. Disking old broomsedge fields stimulates growth of native wildlife plants. Improving the fertility of the soil is prerequisite to the substitution of desirable forage plants.
8. Threshing crimson clover seed by hand to expand the winter cover acreage. Farm seed plots of crimson clover are important in the soil conservation program.
9. Terraces and contour cultivation provide mechanical aids to holding soil. They also store up rainfall, allow it to soak into the ground for use in time of need.
10. Crimson clover furnishes winter protection and organic matter; holds plant food through the winter, keeps it from being leached out by winter rains.
11. Meadow outlets mean more hay, as well as safe disposal of water from terraces. A smooth surface, an even grade, and a good grass cover prevent such drainageways from becoming waste areas of gullies and marshes.
12. Close-growing crops such as millet and grain sorghum provide feed on Georgia farms. District farmers include in their program enough animals to supply home needs for fresh meat, milk, and eggs.
13. Terraces break long slopes and divert run-off water safely out of fields. Vegetation alone cannot assure complete protection where the soil is too poor to produce adequate cover and where rainfall is in excess of the capacity of the soil to absorb it.
14. Combines may be used for harvesting seed of lespedeza sericea and other erosion-resisting crops. Many grasses can be harvested and sown without threshing. The straw affords excellent cover for the young seedlings.
15. Austrian winter peas add organic matter and nitrogen to eroded soils. Like crimson clover, they save plant food that would be lost if the soil were left bare.
16. Mulching and seeding transform useless gullies into wildlife havens. Mulching is often the difference between failure and a success in seeding raw subsoil.
17. Vegetative outlets are replacing gullies for terrace water disposal. Such outlets require maintenance to insure the growth of a uniform cover. Properly kept up, they are assets instead of hazards.
18. Many new close-growing crops such as millet are finding favor in the land of cotton. Most of them are good as livestock feed. Since they demand less working of the soil than clean-tilled crops, the rate of destruction of organic matter is reduced.

GEORGIA FARMERS AT WORK IN THE DISTRICTS



Drama in the fields: A great State labors toward the revision of its use of the land. Farmers adjust and pool their objectives, combine their resources, take advantage of all the technical services available. They hope, through district instrumentalities, to check the wastage of soils, to improve productiveness, and to safeguard investments.

(See opposite page for detailed explanations of the pictures above.)

pointed to a tenant Security farm, now banded with lespedeza, breasted with kudzu. He remarked "This was at one time one of the wealthiest agricultural counties in Georgia." Even now the area is dotted with the once grand homes of moneyed estates. Vansant held the large landowners and absentee ownership partly responsible for what ensued.

"One-third of the present population is dependent upon the Farm Security Administration," he declared. "There was no other means of obtaining credit. But our farmers were ready for a permanent remedy—they turned naturally to soil conservation and better land use proposals. We sometimes furnished the money to buy mules. We financed the payment of rents in advance, so that landlords could pay for repairs to buildings and the development of the land. We financed to a considerable extent the whole soil-conservation program here. We know that rehabilitating the land has an intrinsic bearing on rehabilitating the people."

I STOPPED at Eatonton to talk with W. F. Leverette, manager, about the unique undertaking of the Plantation Piedmont project, a land utilization enterprise of the Soil Conservation Service. The project lies partly within the Piedmont district, with which it works in close collaboration. Of the original acreage of 120,000, some 13,000 acres have been turned over to the Georgia Experiment Station, 30,000 to the United States Biological Survey, 5,000 to the Southern Forestry Experiment Station. Of the 452 families which originally dwelt here, only 116 remain—the others having been absorbed by the Farm Security Administration or having drifted away.

The Plantation Piedmont project was one of the first projects of its kind in the country. Its chief interests are fourfold: Forestry, grazing, upland game and wildlife, recreation. At the outset of its program, a survey showed that the annual income of its wards whittled to perhaps less than \$75 per family per year. The project proceeded to select areas capable of providing permanent subsistence for at least 50 families. These workers' subsistence units consist of truck patches and a few cows, the home production supplemented by W. P. A. wages for work in fire prevention, the maintenance of roads, and kindred jobs. For vast distances roundabout, there were no recreational facilities; the project has now developed two large lakes, has strung 72 miles of telephone lines, and erected five towers for fire prevention. The land is a natural habitat for quail, squirrel, coon, fox, rabbit, dove, and wild turkey, and wildlife will be given a chance to

come back. Soil conservation is the prime concern, for to its neglect in the past are attributable many of the ills that befell. The district, therefore, has a task to perform. And the Plantation Piedmont project families, with full legal status as land "occupiers" vote for district supervisors and cooperate in the safeguarding of their plots.

A LARGE fan is the farm of E. C. Duvall, 9 miles northwest of Greensboro. The handle leads to the highway and the webbing edges the murky Oconee. A property somewhat run-down but of interesting potentialities, this farm is experiencing a rapid transformation under its new owner, who is ambitious to see what correct land usage can do on his alluvial and sandy loams. Duvall is a staunch cooperator, sees his own problems in relationship to the problems of his neighbors. He showed me his hotbed, his contoured pasture, his smokehouse with immense sides of pork and a 40-pound ham; a well-planned, high-lofted barn financed by Farm Security funds, a handsome stallion. Duvall proceeds on a live-at-home, self-sufficiency basis; looks several years ahead to the time when his water-disposal system will be complete, the terraces and strip-cropping and soil-building rotations paying dividends.

Ahead are 5 busy years of installing diversion channels, of constructing and seeding Bermuda grass and kudzu meadow strips, of retiring lands to pastures developed of kudzu crowns and superphosphate and barnyard manure, of kudzu-covering gullied areas, of rearing fences for protection of grass and trees, of building brush dams, of harrowing and seeding in lespedeza and Dallis grass and white Dutch clover, of culling and pruning for fuel supply and woodland improvement. Rotations, carefully projected through the years, will provide cotton, corn, small grains, winter cover crops, summer hay. The written agreement between district and cooperator is complete, detailed, clear, and definite; it sets forth the when, the where, the how, and the who of each operation. The district obligates itself to map the farm, to survey the terrace and contour furrow lines, to furnish instructions for the construction and treatment of terrace outlets, to stand by with agronomic and other technical advice. The owner furnishes most of the labor and materials. "The district soil conservation plan is practical for my farm," says Duvall. "And the more farms that come under the plan, the more effective it should prove to be."

THUS concludes a preview of the districts film: an odds-and-ends assortment of glimpses and impressions, of lights and shadows projected against

the earthy surfaces that are Arkansas and Georgia. The picture is of minds and men in meeting, of human relationships, and social intangibles. Mass education and intensive activity; the farmer on the one side and the technician on the other; soils' problems in the same bag with economic problems; the farmer pressing to obtain service and the district staff struggling to satisfy his need: These, too, are important to the drama of a young idea hastening to maturity. In the background range the pioneering demonstration proj-

ects of the Soil Conservation Service; in the foreground, the forces of continuing research—forces like the Southern Piedmont Experiment Station at Athens, delving into studies of the contour-balk method of growing cultivated crops. This report aspires to reveal only a slight silhouette at gray dawn—a suggestion of what is transpiring in the beginning phase of what may prove to be a different, and more pleasant, period in the history of the land and of its use.

Insects and Conservation

By F. C. Bishopp¹

Sod loosened by white grubs and lifted to show some of these insects.

IT IS only necessary to observe a swarm of grasshoppers spreading over a field or pasture to visualize the part these devastating insects can play in stripping the land of its protective cover, and setting the stage for erosion. Moreover, these outbreaks usually occur in the semiarid West, where the retention of moisture is a vital need and where wind erosion is most likely to occur. At their worst these hordes of hoppers may denude hundreds of thousands of acres so completely that scarcely a sprig of green vegetation remains, and many of the blades and crowns of the dry grass plants are consumed. Even in years of severe drought, vegetation normally makes sufficient growth to give considerable protection to the soil surface if it is not stripped by insects or other agencies. Even during periods when grasshoppers are not present in outbreak proportions, the vegetation destroyed reaches an impressive total.

The destructive effects of grasshoppers serve only to illustrate strikingly what is being done less conspicuously by many other groups of insects. There are literally hundreds of leaf-eating species and perhaps even a larger number which suck the juices from the plants, reducing their size and vigor, or even causing them to wither and die. Other insects destroy the seeds, crowns, and roots of plants, and still others



devour the nitrogen nodules on legumes, so important in the improvement of many soils.

If we should follow our inquiry into the earth's crust, we would find it literally teeming with minute animals, many of which are insects. It has been estimated from careful examination of typical areas that the insect population runs from 2,000,000 to nearly 13,000,000 per acre. Some of these insects are truly beneficial in the aeration and formation of the soil, their work making it more pervious and thus more retentive of moisture.

Just what part insects play in the breaking down of plant tissue into leaf mold and humus and of animal matter into materials suitable for plant food has not been definitely determined, but it is by no means small. Much attention has been given to the soil-conditioning action of earthworms since this matter was forcefully presented by Darwin, but the role played by insects in this respect has been largely passed

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over. N. S. Shaler, of the United States Geological Survey, in a report published in 1891, had the following to say with reference to "the common brown ant":

On a field in Cambridge, Mass., observations made during two summer seasons showed me that the average transfer of soil matter from the depths of the surface of the earth was in the aggregate sufficient to form a layer each year having a thickness of at least one-fifth inch over the area on which the observation was made, which is about 4 acres in extent.

Shaler points out that although ants do not have the peculiar effect on the soil of those insects which pass it through the digestive canal, "Nevertheless, because they are much more widespread than their lower kindred, these insects in the aggregate produce a far greater influence on the soil."

Hundreds of species of ants inhabit the soil and work in decaying wood. Termites, while generally destructive, are important in that they disintegrate vegetation and otherwise aid in soil formation. This is especially true in the Tropics and in the southern portions of this country. Dung beetles not only aid in soil aeration but also carry into the soil considerable quantities of manure. On a certain area of pasture land in Kansas an entomologist found that one species of this group of beetles made 200 burrows per acre. Some of these were nearly 2 feet deep and in them were buried 21 pounds of air-dried dung. Many species of beetles, cicadas, bees, wasps, and insects of other groups live more or less within the soil and contribute to its aeration and renovation.

Insects have demonstrated only too strikingly and too often their importance as destroyers of our forest resources and as creators of conditions favorable for floods and erosion. The precise effect of extensive defoliation of trees by such insects as the gypsy moth, the spruce budworm, the pandora moth, and the hemlock looper on the retention of moisture has not been determined, but there is no doubt that such extensive defoliation weakens the trees so that they are more susceptible to destruction by storms. The killing of trees by such insects as bark beetles sets the stage for devastating fires followed by floods and erosion. Insects such as white grubs are often responsible for the destruction of forest nursery stock so vital to a large-scale reforestation program, and many insects are concerned with the destruction of seeds necessary to natural reseeding of forest areas.

Shifts in crops or agricultural practices, such as the bringing under cultivation of extensive areas or the withdrawal of such areas from agricultural production, are nearly always accompanied by troublesome insect problems. Propagation of such destructive insects as the beet leafhopper, various species of grasshoppers,

and cotton flea hoppers takes place on weed-covered areas during the transformation from cultivated crops to grasses and other permanent vegetation.

Soil conservation is so intimately tied up with cropping methods, and the latter with insect problems, that these interrelations must be given careful consideration. In many instances there is at hand too little definite information to indicate just what may be expected from a given procedure. Quite often results may be influenced considerably by local or seasonal conditions.

In a list of 50 important insect pests of corn, wheat, and red clover in Illinois, compiled by entomologists working in that State, 8 of the corn pests are found among the pests of wheat and only 3 species are serious pests of all 3 of those crops. This suggests the opportunity presented to farmers of arranging a crop rotation that will minimize the danger of building up to serious proportions a number of insect pests.

Clean culture, though conducive to erosion, is of much importance in combating certain insect pests. For example, the infestations of the southern corn rootworm may be avoided by practicing clean culture until the eggs are deposited, as this pest will not lay its eggs on bare soil.

Destruction of crop residues, while objectionable from the erosion point of view, is often an important step in combating a pest, as in the case of the European corn borer and other insects which hibernate in fields.

Strip farming may favor certain destructive insects if the crops are not carefully selected with respect to insect relationships. For instance, the planting of grain in strips with intervening strips summer fallowed seems to be favorable to the lesser migratory grasshopper. The eggs of this species are laid in the unplowed stubble, and upon hatching the young hoppers immediately enter the adjacent crop. Strip planting which brings corn and grain close together is likely to intensify chinch bug injury, and many other examples of undesirable crop combinations might be cited.

Fall plowing is objectionable in areas where erosion is an important matter, but leaving fields unplowed is favorable to many pests such as bollworms, cutworms, strawworms, and the hessian fly. Time of cultivation, types of cover crops grown and turned under, and many other cropping practices may have a direct and important bearing on insect depredations.

Soil-improvement undertakings through the extensive planting of legumes is intimately associated with the welfare of the honeybee. The swing from legumes to cash crops during and subsequent to the World War had a disastrous effect on the soil and has resulted

in a marked decline in the number of honeybees in the agricultural West. The extensive planting of legumes in soil-improvement work is dependent on an ample supply of seed, and bees are a necessary factor in producing satisfactory seed yields. Bees also play an important part in the production of cultivated fruit and of fruit and seeds upon which wildlife depends.

Overgrazing is not only an important cause of wind and water erosion but it, coupled with intermittent farming, has served to intensify one of the most serious insect problems of the West—that of the beet leafhopper. This insect transmits the curly top disease of sugar beets, tomatoes, and other crops. Heavy losses from curly top are associated with the occurrence of high populations of the beet leafhopper. These high populations are produced as a result of the availability to the insects of extensive areas of summer weeds, such as Russian thistle, bract scale, and fogweed, growing on intermittently farmed lands, and of winter weeds, especially plantain, peppergrass, and mustard, which appear on vast overgrazed areas.

The impounding of water for flood control, irrigation, or power projects, for maintenance of water table, or for the purpose of fostering wildlife often results in the production or intensification of certain insect problems. Mosquitoes are the pests usually involved. These insects are of such tremendous importance because of the role they play as annoyers, and in the transmission of malaria and other diseases of man and animals, that they must be considered in connection with nearly all water manipulations. By recognizing this fact in planning such projects, the more serious aspects of the problem often may be taken care of as the work progresses.

Insects and related forms have a very direct relation to wildlife conservation. Many species are important as parasites or carriers of diseases of wild birds and animals. Some wild animals serve as hosts for species which are highly important as pests of man or domestic animals. This is illustrated by the cattle tick problem in Florida. In this instance deer serve to maintain the cattle tick on ranges which, if it were not for these animals, would be freed of ticks by the dipping of the cattle or by the removal of domestic animals from the pastures. Thus the eradication of the cattle tick from the United States—a job which was apparently nearly completed—is now confronted with a new and perplexing obstacle.

This article presents merely an indication of the many ways in which insects, one of the most destructive forces with which man must contend, may affect a conservation program. The rather obvious point

might be made here that insect control is in itself an important conservation measure, since the loss to man through insect depredations in the United States each year has been estimated at the enormous sum of 3 billion dollars.

Much direct or indirect information on the relation of insects to conservation procedure has been obtained by research workers in the Department of Agriculture and in various State experiment stations, yet enough fundamental facts have not yet been gleaned upon which to base answers to many of the questions. Some of these answers are being sought by research organizations, and no doubt the large-scale conservation program now under way will provide others.

While the Windbreak Grows

A North Dakota cooperator is not merely waiting for his 30 acres of trees and shrubs to reach full growth before he does something about wind erosion. Bert Phair, near Park River, is farming his land in strips, alternating fallow or other clean-cultivated land with small grain and similar cover. He leaves the stubble anchored on top of his land as a protective covering against wind erosion and to catch snow. In addition, Mr. Phair cleans and cultivates his 2½-year-old windbreak four or five times a year with the duck-foot, disk, and cultivator. He says that he can clean his entire windbreak in a day's time.

STATISTICAL TABLES FOR BIOLOGICAL, AGRICULTURAL, AND MEDICAL RESEARCH. R. A. Fisher and F. Yates. London and Edinburgh, 1938.

Statisticians and research workers in many fields especially biology, agriculture, and medicine should find this book indispensable. The tables which the authors have brought together may be placed in three groups as follows: (1) Tables which have been published and in use for some time; (2) tables that were not readily available or that are not entirely new; and (3) tables which afford aid in computations. The first group contains, chiefly, those distributions which are used frequently in tests of significance. Among the tables of the second group, persons actively concerned with agronomic research will find those on angular transformations, Latin squares, incomplete blocks and orthogonal polynomials especially valuable. Tables of logarithms, squares, reciprocals and other such aids in computation contained in the third group are, of course, available in other places but it is a great convenience to have them available in the same book with the first and second groups.

In the 22-page introduction the authors have discussed the various tables and explained their use. A number of examples has been provided to illustrate important uses of some of the tables. In addition a most pertinent and useful discussion of interpolation with examples has been included.

The size of page, 8½ by 11 inches, limits this book to desk use. It has, however, enabled the printer to produce tables that can be used with a minimum of eye strain and of errors due to reading.—Dr. A. E. Brandt.



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neill Faris



SEVEN LEAN YEARS. By T. J. Woofter, Jr., and Ellen Winston. University of North Carolina Press. May 1939.

One closes this extraordinarily illuminating study of depression years with the firm conviction that problems of rural distress should be approached from "down under," that the educational road is the true road, and that there is no insurmountable difficulty to a people willing and eager to search out the way and follow it. It is for this reason that the book is discussed in this issue of *SOIL CONSERVATION*. The soil conservation districts idea does get "down under," to the human element as well as the soil element of the widespread movement for rural reconstruction. Better to understand what it is that we are working for, the great complexity of the rural pattern of today, it is suggested that at least several hours of several days or nights be given over to careful and sympathetic reading of this volume which the authors have aptly called "Seven Lean Years"—especially by those of us who are working in soil conservation.

There is nothing emotional about the presentation; it is, in fact, a rather austere telling, in cold facts and figures, of troublous times in rural America "because of sweeping changes acutely felt but only dimly understood." The thoughtless, or the individual little concerned, may ask, Why should we be reminded, thus starkly and sombrely, of suffering and poverty in millions of farm families, whether temporarily or permanently "submerged"? The answer definitely is this: It is only by pointing out causes of the present agricultural economic situation, trends, relief costs and needs, relationships of agriculture and industry as indicated by present trends, consequences of land misuse and population increase in poor areas, errors—it is only thus that long-time preventive measures can be envisioned and worked out for the future, that it may not happen again. Can it be done? And why not, in America? Nothing should be impossible, in the United States.

The authors have worked for several years in the Division of Research of the Federal Emergency Relief Administration and the Works Progress Administration, and they have taken a great bulk of facts contributed by rural research staffs and fused the whole into a nontechnical analysis of fundamental aspects of maladjustment, present and past, in rural areas. They point out, also, urgent needs for readjustment in special areas; and by illuminating the facts concerning destitute people in such areas they contrive to offer constructive suggestions for alleviating distress both through emergency measures and decade- and century-long planning. The whole study ties in closely with the hopes and plans and operations of the Soil Conservation Service.

A particularly vivid picture is given of mass suffering, and high emergency-relief costs, in part-time farming areas. Millions of farm people, especially youth, dependent for opportunity and income upon small rural industry—lumbering, mining, rural manufacturing; collapse of such industries and "ghost" villages; to the city, back to the small farm, relief on the farm and in the city, to the city again and back to the farm for an illusion of safety; a mad scramble, with unrest and the evil consequences of installment and farm mortgage. In 1928 the farm mortgage debt amounted to 9½ billions of dollars. Largely contributing to rural-relief costs were farmers who had lost their lands through mortgage foreclosures, with tenants turned adrift. But it was the part-time farming areas, with stranded villages and small worn-out farms, that came earliest to the relief rolls, stayed longest, suffered most.

In a discussion of past and present trends leading toward insecurity in agriculture Dr. Woofter and Dr. Winston point out in no indefinite terms the extraordinary difficulties that must be surmounted in coordinating mechanization, population increase, and

production control, in working out a fundamental solution of the submerged farmers' problems to prevent future rural emergencies. Poorest farming areas have highest population increase; mechanization, employing less manpower, tends to increase; demand for agricultural products increases with population increase provided the buying power of the people permits. The three appear to be irreconcilable, yet as one reads on, the outlook works its way toward more hopeful thinking. Correction of land ills, conservation of good soils, adequate health services in the poorer rural areas, vocational training and opportunity guidance for the great army of youth faring forth each year from these areas, migration guidance, improved distribution of tax money—these and other measures work for the good of a great many depressed areas, work slowly but *work*. And, these measures are fundamental. A population policy, urged by the authors of "Seven Lean Years," might conceivably be a natural outcome of consistently applied efforts, pursued with determination and much thoughtful planning, to correct fundamental ills of the poorer rural areas.

Two chapters of the book present a finely drawn and comprehensive picture of the status of landless and low-income families of rural areas and the effect of such groups on the relief problem. Tenancy receives broad treatment, and the share-cropper's plight is painted in all its hideousness with cold figures as the impressive media. Areas of special problems are treated convincingly—the cotton and corn areas, the "agricultural fringes," ghost-village areas. And then the broad regions of chronic distress, including eastern cotton, western cotton, Appalachian-Ozark, Lake States cut-over, spring wheat, winter wheat. These are areas of stagnant trade and agricultural hazards, high-birth rates, and deplorable living conditions. Drought distress in the high plains where it is possible to gage the ebb and flow of people with the climatic pulse is analyzed chiefly from the point of view of recent emergency relief—in 1935 one out of every five families in the Great Plains was on the relief rolls, farmers, merchants, doctors, teachers. Carefully correct figures and statements are given to point out causes, handicaps of farm laborers and farm owners, and other relief households.

In the final chapter of the book, Relief and Reconstruction, we look for some bright ray of hope. We find it in these words: "Much of the distress which these [relief] expenditures helped alleviate has been shown to be preventable, and all possible measures should be taken to guarantee that the situation which caused that distress shall not arise again." We have learned of the mutual dependence of industry and agriculture; the extent of rural slums, some of long standing; that the pioneering era is gone forever; that a long-range program of conservation of the land is imperative; that the submerged rural group exists today, the result of exploitative agriculture and that it should not be permanent if land use and social education is properly applied; that relief of unemployables and employables are separate, specialized processes. And we have learned to weigh with care work relief and direct relief.

Above all, the final chapter of Dr. Woofter's and Dr. Winston's book should be read for an understanding of unemployment as a normal phenomenon of the economic system rather than the result of a passing emergency. The goal of farm relief should be to reestablish them as farmers—on a permanent basis. Certainly, as stated in the end, "widespread need must not occur again."

If the pattern of agriculture is favorable to wildlife, then wildlife will be abundant. If the pattern is unfavorable, or only fair, then we shall have wildlife in proportion.

Soil Conservation Topics Treated For **REFERENCE** In Wide Range of Recent Bulletins

Compiled
by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Graphic Solution of Open Channel Dimensions. SCS-EP-15. April 1939. mm.¹

Hourly Precipitation on the Upper Ohio and Susquehanna Drainage Basins for month of January 1938. SCS-PC-1. April 1939. (Distribution restricted to Federal and other agricultural offices engaged in activities in the Upper Ohio and Susquehanna Drainage Basin areas.)

Office of Information U. S. Department of Agriculture

Food Habits of North American Diving Ducks. Technical Bulletin 643. Bureau of Biological Survey. April 1939.

Food of Game Ducks in the United States and Canada. Technical Bulletin 634. Bureau of Biological Survey. March 1939.

An Outline of the Water Facilities Program. Soil Conservation Service. 1939.

Principal Laws Relating to the Establishment and Administration of the National Forests and to Other Forest Service Activities. Miscellaneous Publication 135. Forest Service. Revised January 1939.

Report of the Puerto Rico Experiment Station, 1937. Office of Experiment Stations. November 1938.

The Timothy Crop. Leaflet 171. Bureau of Plant Industry. February 1939.

Wildlife of the Atlantic Coast Salt Marshes. Circular 520. Bureau of Biological Survey. March 1939.

Wildlife Restoration Program Under the Pittman-Robertson Act of 1937. Miscellaneous Publication 350. Bureau of Biological Survey. May 1939.

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Better Land Utilization for Ohio. Mimeograph Bulletin 108. Department of Rural Economics, Ohio State University and Agricultural Experiment Station, Columbus, Ohio. June 1938.

Grasses and Legumes for Pasture and Hay. Circular 64. Agricultural Experiment Station, North Dakota Agricultural College, Fargo, N. Dak. March 1939.

Laboratory Tests of Field Crop Seeds as Indicators of Seeding Value. Research Bulletin 239. Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, in cooperation with Bureau of Plant Industry. September 1938.

Land Transfers in Twelve Counties in Nebraska, 1928-1933. Research Bulletin 107. Agricultural Experiment Station, University of Nebraska, Lincoln, Nebr. November 1938.

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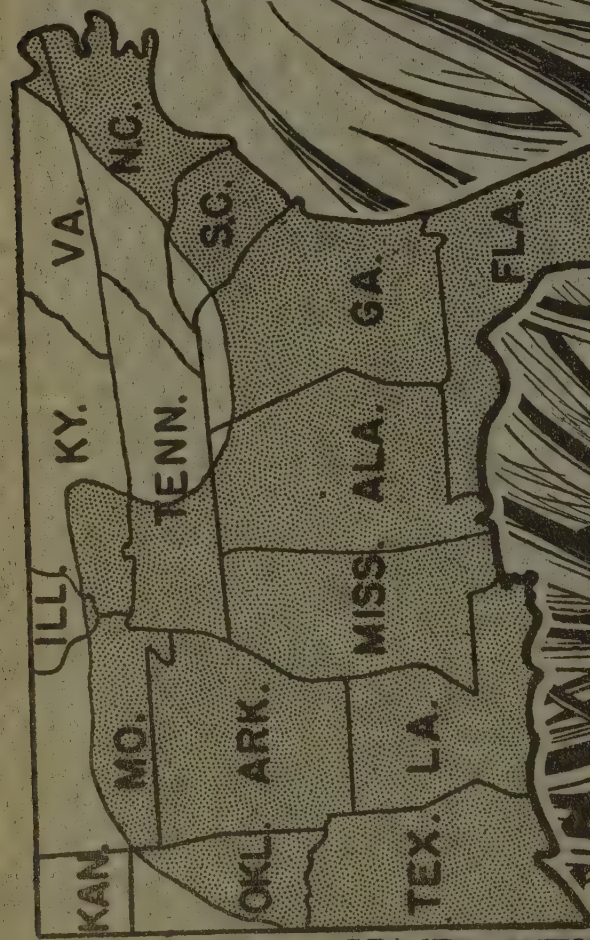
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